MACHINERY.

Vol. 8. December, 1901. No. 4.

DEEP HOLE DRILLING.

A COLLECTION OF USEFUL DATA COVERING BOTH LARGE AND SMALL WORK.

GENERAL PRINCIPLES.

THE RELATION BETWEEN ORDINARY DRILLING AND DEEP HOLE DRILLING.

The process of drilling deep holes in metal is a familiar one in many shops, particularly where firearms are manufactured or heavy ordnance is constructed. Since the adoption of hollow spindles for lathes and other machine tools the methods for machining the bores of guns have been employed in machine-tool shops for drilling these spindles; and through this and other means the principles of the operation have become better understood. It is not an easy matter, however, even with the best appliances, to drill or bore a deep hole, smooth and round, of exactly the required diameter from end to end, and perfectly straight. While many mechanics are familiar in a general way with the methods and tools for doing this work, we think some specific information upon the subject will be appreciated by those who have not had actual experience in deep hole drilling.

It is well known that a long, or deep, hole—that is, one long in proportion to its diameter—is best roughed out and finished by using a tool on the end of a long bar, which enters the work from one end. This is true, whether drilling into solid metal or boring and reaming a hole that has already been drilled or bored out. A boring bar which extends through the piece and on which is either a stationary or a traveling head is not satisfactory for very long work, owing to the spring and deflection of the bar, which is made worse by the fact that the bar must be enough smaller than the bore to allow room for the cutter head. While a long hole may sometimes be finished satisfactorily by means of such a boring bar, by packing the cutter head with wooden blocks which just fill the part of the bore that has been machined, and so support the bar, the method is fundamentally wrong for long work.

The best methods for machining deep holes are nothing more nor less than an adaptation of what has been found successful in ordinary drilling and boring by means of the engine lathe or chucking machine. We will therefore discuss certain types of chucking tools and drills, and show their relationship to tools that may be used for deep hole drilling. To complete the subject there are then published two articles by contributors, one of which explains the methods developed by the Pratt & Whitney Co., Hartford, Conn., for drilling gun barrels, and the other the tools used in boring and reaming the bores of large guns.

The Flat Drill.

To start with first principles, take the ordinary flat drill. It is useful for rough work or in drilling hard metals, because it can be easily made and tempered; but it has the faculty for drilling holes that are neither round nor straight, and whose diameter seems to bear no relation to the diameter of the drill. When a flat drill runs into a blow hole or strikes a hard spot, it is deflected, as in Fig. 1, the only resistance to this deflection being the narrow edges of the drill. Under such conditions the hole will be out of round and crooked.

Add to this natural tendency of a flat drill to run out, the fact that such drills are often carelessly made, and one understands why they have the reputation for poor work. Thus, if the point is not in line with the axis of the drill, and if the lips are of unequal length or do not make equal angles with the axis, the hole will be larger than the drill diameter. This is illustrated in Fig. 2, where one lip is longer than the other and the point does not lie in the central axis of the drill. The tendency of the drill is to rotate about its point and thus the axis will move in a small circle about this point, causing the hole to be of larger diameter than the drill.

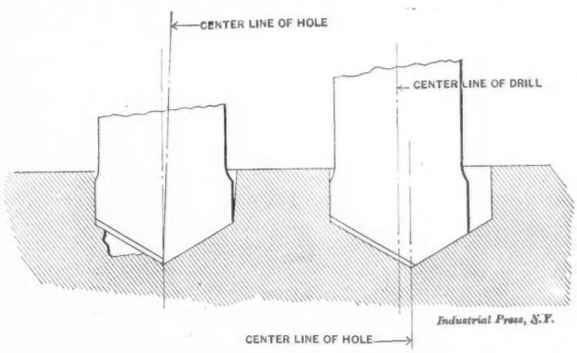


Fig. 1. Fig. 2.

It is obvious that to improve the action of a flat drill it should be so guided as to prevent its wabbling and to compel it to move forward in a straight line. This is partially accomplished with the flat chucking drill, which is a near relative of the ordinary flat drill, differing from it in that it is generally more carefully made and is adapted for use in the engine lathe. In Fig. 3 is a sketch of a chucking drill at work on a piece in the lathe, and to make the comparison fair it is shown with one lip longer than the other, as was the flat drill in Fig. 2. The work is held in the lathe chuck and turns with the spindle. A rest steadies the drill at a point near the work and in starting the hole the drill is held firmly against the rest by means of a monkey wrench. It will be noted that while a poorly ground chucking drill will make a large hole, just as does the drill in Fig. 2, if properly started it will not wabble and it will drill the hole where it is

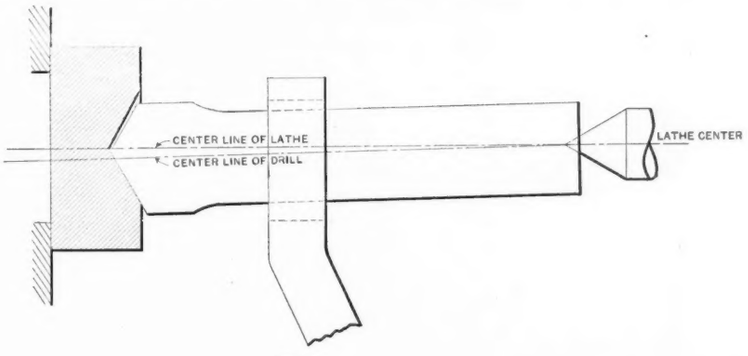


Fig 3.

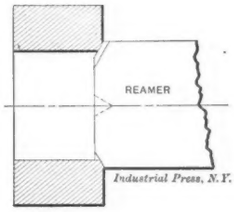


Fig. 4.

wanted and approximately in line with the lathe centers. To attain these results, however, the drill must be started right. If it is found to wabble when left free, it must be started over again, before the full size of the hole has been attained, by crowding it into the work and toward the operator at the same time, causing only one edge of the drill to do the cutting. This edge will then true up the hole and in proceeding with the drilling the trued hole will guide the drill. The latter will thus be continuously supported near its cutting edges by the cylindrical surface of the hole, and the drill will tend to advance in the direction in which it was started.

After the hole is drilled, it is usually brought to size by a flat reamer, like Fig. 4. For reasons that will be explained, the flat drill is not an accurate tool, even when well made and used in the lathe, and the flat reamer is not as reliable as one with more blades.

The general principle, however, of first starting with a true hole, and then having the drill body designed to follow in its path and so guide the cutting edges, is the fundamental principle of deep hole drilling.

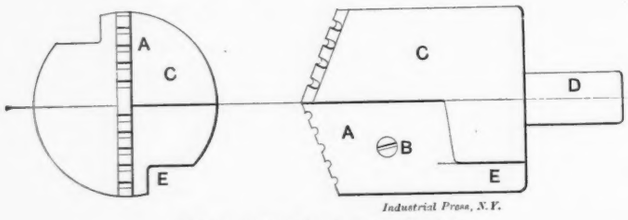


Fig. 5. Flat Drill for Deep Drilling.

Fig. 5 shows how a flat drill may be adapted for deep hole drilling. The drill from which the sketch was made was employed for drilling a four-inch hole through steel rolls seven feet long and was illustrated in the June, 1899, number of MACHINERY. Instead of depending upon the narrow edges of the drill proper to guide and support the cutting edges, a blade is inserted in a cylindrical cast-iron head, the outside diameter of which is turned to a sliding fit in the hole that is being bored. The cutting edges are grooved to break up the chips, enabling them to pass out through the passage *E*, on each side of the head. The grooves are laid out so that those in one blade come opposite to the lands in the other blade. In the illustration, *A* is the cutter, *B* one of the screws holding the cutter to the head *C*, and the head is attached to the bar by the shank *D*.

The Twist Drill.

The modern twist drill accomplishes all that is attained by the arrangement in Fig. 5 and in addition can be ground without seriously affecting the rake and will free itself from chips more readily, owing to its spiral flutes. The lands of a twist drill present a large cylindrical surface to bear against the sides of the hole and take the side thrust. If the drill is also guided by a hardened bushing, at the point where it enters the metal, as in the case of jig work, the drill will have very little chance to deflect and the hole will be accurately located and will be quite true and straight.

The twist drill in modified form is also employed for deep hole drilling. The hollow drill, shown in Fig. 6, and introduced by the Morse Twist Drill Co., New Bedford, Mass., is adapted for this purpose, and in Fig. 7 is the arrangement recommended by this company for feeding the drill into the work. The drill has a hole lengthwise through the shank, connecting with the grooves in the drill. The shank can be threaded and fitted to a metal tube which acts as a boring bar and through which the chips and oil may pass from the point of the drill. Oil is conveyed to the point on the outside of the tube, as shown in Fig. 7.

Fig. 6. Hollow Twist Drill for Deep Drilling.

In using the hollow drill the hole is first started by means of a short drill of the size of hole desired and drilled to a depth equal to the length of the hollow drill to be employed. The body of the hollow drill acts as a stuffing, compelling the oil to follow the grooves, and the chips to flow out through the hollow shank. The methods of supporting and driving the work, and of feeding the drill, are clearly shown in Fig. 7. Drills of this type are regularly manufactured in sizes up to three inches in diameter and in the catalogue of the Morse Twist Drill Co. it is stated that the best results are obtained when drilling crucible steel by revolving the drill 20 feet per minute, with a feed of .0025 inch per revolution, while machinery steel will admit of a speed of 40 feet per minute and a feed of .0035 inch per revolution.

Number of Cutting Edges Desirable.

When drilling a hole out of solid stock, some type of drill having two lips or cutting edges is usually the most feasible, and probably nothing will be devised that on the whole surpasses the twist drill for such work. An end mill, like that in Fig. 10, can be used for drilling, if it has a "center cut," and it will presently be explained how a tool with a single cutting edge may be advantageously employed, particularly for deep hole drilling. The familiar D-drill is of this type, and also its modification as used by Pratt & Whitney, in drilling gun barrels.

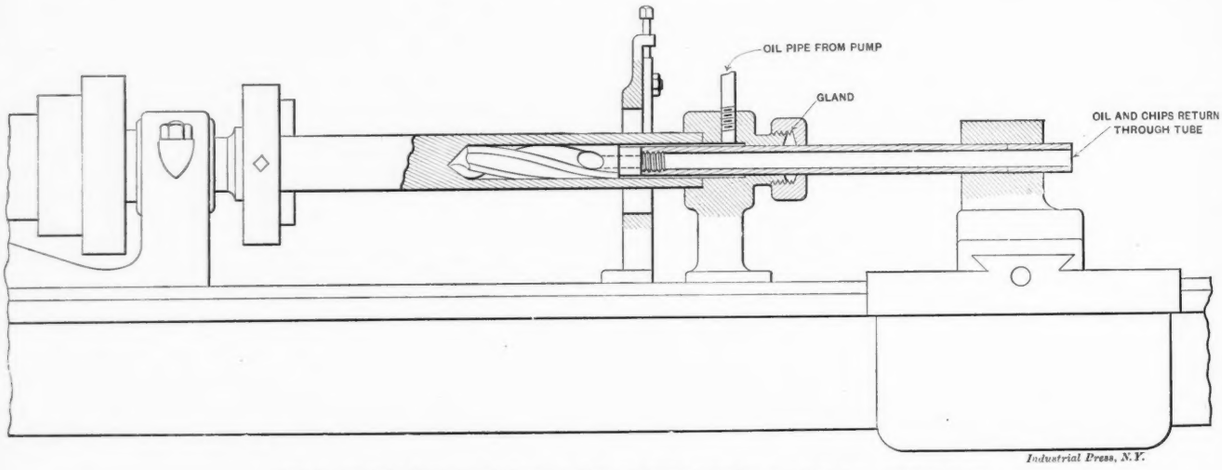


Fig. 7. Method Recommended by the Morse Twist Drill Co. for Using the Hollow Drill.

When it comes to trueing up or enlarging a hole previously drilled or bored, the two-lip drill is not suitable in any of its forms. For boring a true hole nothing can surpass a single-pointed boring tool, the ideal condition for finishing a hole being when the cutting point is a real diamond, or a rotating wheel of abrasive material.

It is obvious that when a hard or soft spot is encountered in boring with a tool having a single cutting edge, only that particular place is affected by the spring of the tool; while with a double cutter, as shown in Fig. 8, first sketch, any

deflection due to irregularities, such as at *a* or *b*, will cause the tool to spring and the cutting edge on the opposite side to introduce similar irregularities in the opposite side of the hole. This is one objection to the two-lip drill for accurate work.

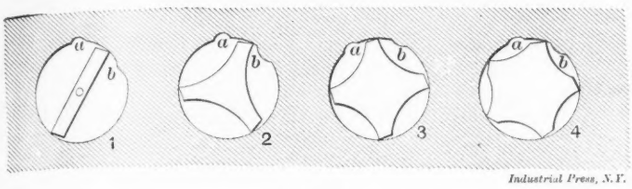


Fig. 8

With three points the tool is somewhat better supported when a high place is encountered, as at *b*, Fig. 8, and when a cutting point strikes a low place the other two edges are not moved away from their positions so much as if they were opposite the first edge. Hence a tool with three edges should prove better than one with two, and one with four, being better supported, is better on this account than one with three, but has the disadvantage of opposite cutters. Five edges ought to give better results yet.

Fig. 9. Four-lip Drill for Trueing a Rough Hole.

In Fig. 9 is a sketch of a four-grooved chucking drill which is suitable for trueing up either a drilled hole or a cored hole, but obviously it cannot be used for drilling out solid stock. It has less tendency to "run" than a two-lip drill and the edges are less liable to catch under the scale or in breaking through, since each has only half the depth of cut to take.

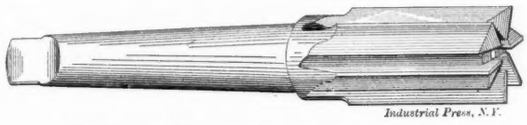


Fig. 10. End Mill, suitable for Accurate Drilling.

In general it may be said that in boring the best results are obtained when the tool has a single cutting edge, but if it is desirable to have more cutting edges, a tool with several will be more satisfactory than one with only two. Any machinist who has tried to true up the taper hole in a lathe spindle, first by boring and then by reaming, will appreciate the superiority of the boring tool over the multi-blade reamer. A reamer sometimes refuses to produce a perfectly round hole and will do this whether the number of teeth is odd or even. The writer has seen the photograph of the bore of a 12-inch gun that had been reamed out with an eleven-sided reamer and the bore had eleven distinct sides, clearly visible in the photograph. The trouble was overcome by spacing the reamer teeth unequally.

Advantages of the End Cut.

One trouble with reamers, however, is that the teeth necessarily cut on their side edges instead of on their ends and the whole effect of any unevenness in the hole is to crowd the reamer to one side. The same condition exists to a less extent with a flat or twist drill, where the cutting edges are at an angle with the center line and the resultant of any unusual pressure is felt partly as a side thrust and partly as an end thrust. Now, by making a drill to cut squarely on its end and but very little, or not at all on its sides, the side thrust is mostly done away with. The end mill shown in Fig. 10 is a good illustration of such a tool, and it is known to be capable of boring very accurate holes when used for the purpose in the milling machine.

In Fig. 11 is a boring tool, with a single cutting edge, which cuts on its end and is capable of drilling a true hole in solid metal. It was illustrated in the August, 1896, number of MACHINERY. It consists of a round, tool-steel bar, with one end flattened and ground to form a cutting edge, as shown.

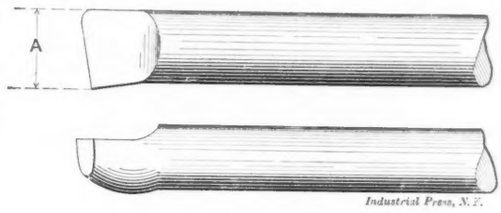


Fig. 11. Boring Tool with End Cut.

It is designed to be held in the tool post of the lathe, in a position perpendicular to the face plate. The inner edge or corner of the cutting edge should be slightly rounded to help support the cutter and prevent chattering and the width *A* of the cutting edge should be from 1-32 to 1-16 inch less than the radius of the hole to be drilled.

The objection to this tool is that it cannot be supported stiffly enough by the tool post for a hole of great depth and for this purpose the D-drill shown in Fig. 12, and which works on the same principle, is well adapted. In its simplest form it consists of a round bar of the diameter to be drilled, one-

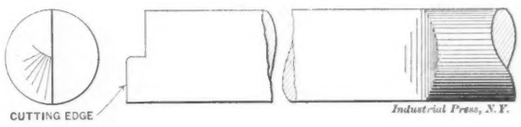


Fig. 12. D-drill used for Deep Drilling.

quarter to one-half of which is milled out to give a passage for the chips. The end of the bar is shaped with a cutting edge on one side, extending almost or quite to the center and with the other side relieved to give clearance for the cutter. Such a drill should be supported by a bearing close to the bar to be bored, in case it is to start the hole itself, and it is better yet to start the hole with a twist drill and true it up with a single-pointed boring tool and let the drill be guided by this hole. This is the surest way of getting a hole concentric with the axis of the lathe. As the bar is of the same diameter as the hole the cutter will be supported by one-half the surface of the hole, and if it is once started right in an accurate hole, it will continue in the right direction. It is desirable to have the cutter blade separate from the bar or head, as the case may be, so that it may be renewed orr emoved for grinding, particularly in drilling large holes. In Fig. 13 is a sketch of such a cutter head as used by a large ship and engine-building concern, in drilling pro-

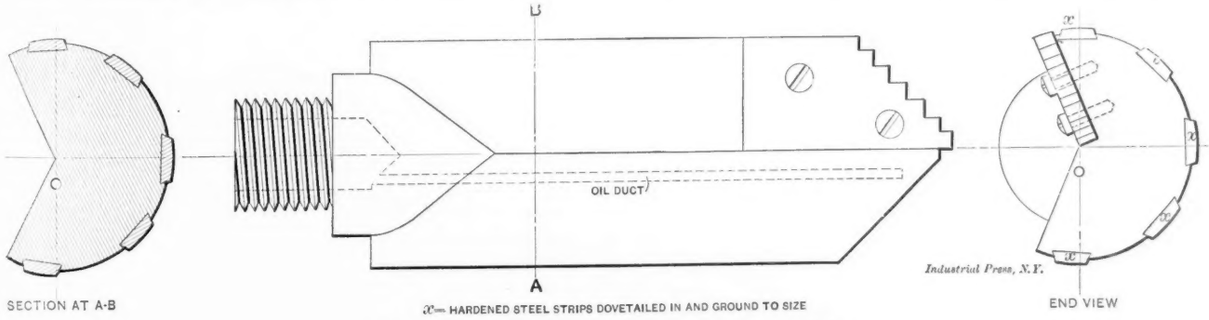


Fig. 13. D-drill with Inserted Blade, used for Deep Drilling.

peller shafts. The body of the cutter is made from soft steel with the tool steel strips dovetailed in and ground in place to the size. The cutters are made by jigs and are interchangeable and their shape is such as to break up the chips which are washed out by the force of oil supplied by an electric pump, through the hollow boring bar, to which this cutter head is fastened. One of these cutters, four inches in diameter, has been 12 inches in a piece of nickel steel in one hour, cutting a fair and smooth hole, and no trouble has ever occurred, even after the hole has been to a depth of 32 feet.

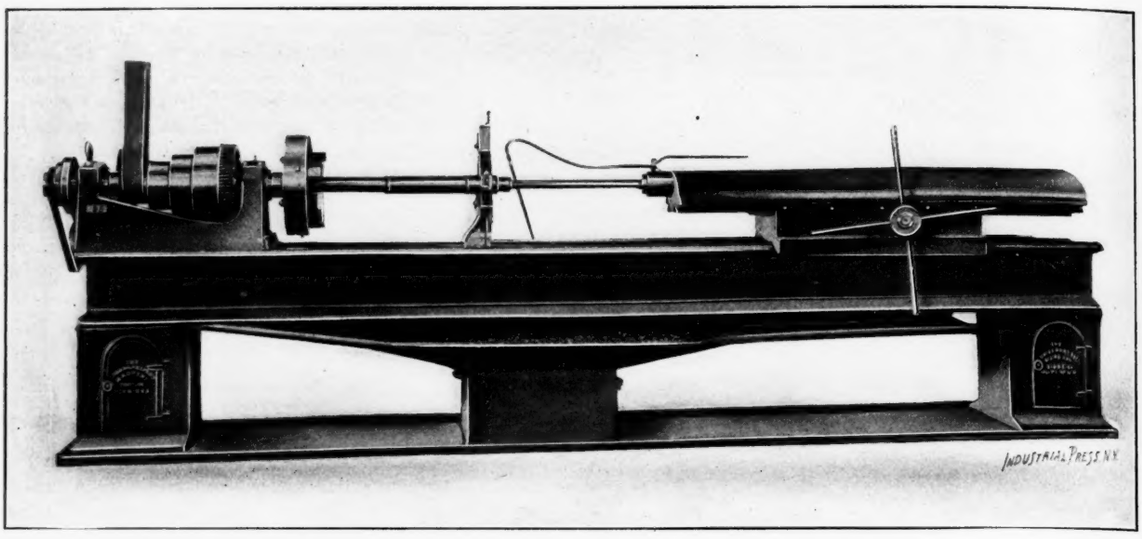


Fig. 14. Drilling Lathe Manufactured by the Lodge & Shipley Machine Tool Co.

Rotating Work vs. Rotating Drill.

In deep hole drilling it is customary to have the drill fixed so that it cannot turn, and rotate the work, following the usual method in this respect for boring accurate holes in the lathe. So far as we know this is done merely because it is the more convenient method and as good results undoubtedly could be obtained by rotating the bar and having the work stationary, provided—and this is the point—the drill were as well supported and guided in one case as in the other. We know, for example, that some of the most accurate drilling is done on the horizontal boring machine and on the milling machine, with rotary cutter and stationary work. A possible difference in the two methods is that when the work revolves the drill would encounter more rapidly moving particles of the metal, if it ran out of line, but we are not prepared to say that this would have an appreciable effect. Since the outer end of the work can be supported in the center rest it is always possible to make the work run true, while it is not so easy to make a drill run true and coincident with the axis of the work.

Drilling Lathe.

While an engine lathe may be used for deep hole drilling, supporting the work in the chuck and center rest, and supporting and feeding the bar by means of the carriage, a drilling lathe is almost a necessity where much drilling is to be done. In Fig. 14 is a neatly designed lathe for this purpose manufactured by the Lodge & Shipley Machine Tool Co., Cincinnati, O. It is essentially a turret lathe, with a bed of any desired length, but with the turret slide removed and in its place there is a long slide for carrying one end of the boring bar or drill. Such a lathe is suitable for drilling lathe spindles or any medium-sized work of a similar character. It has an oil pump to be connected with the oil tube of the boring bar, a pan to catch the chips and oil, and an oil reservoir into which the oil drains and settles, and from which it is pumped.

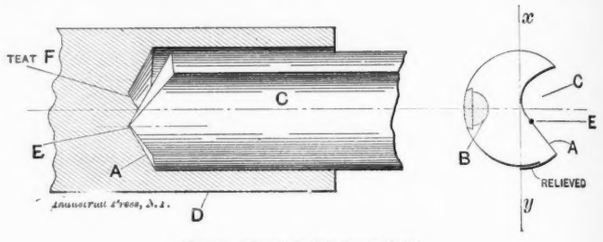


Fig. 1. Pratt & Whitney Drill.

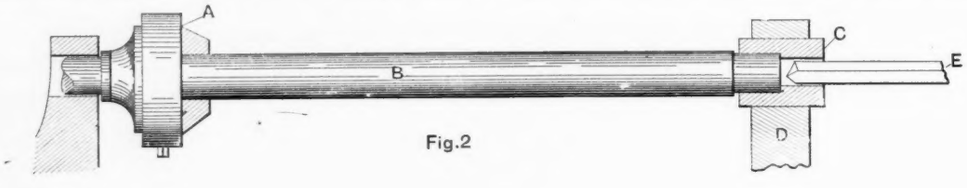


Fig. 2

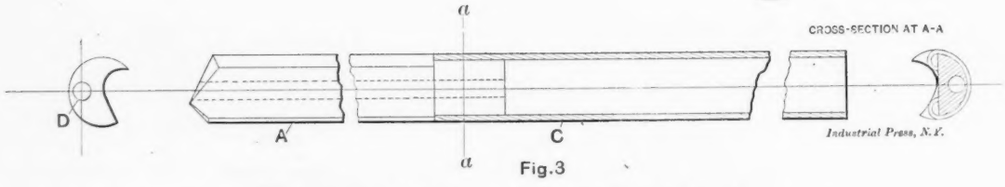


Fig. 3

Fig. 2. Starting the Drill. Fig. 3. Drill and Long Shank.

DRILLING DEEP HOLES BY THE PRATT & WHITNEY METHOD.

CONTRIBUTED BY C. L. G.

A highly satisfactory drill for use in drilling deep holes is one brought out by the Pratt & Whitney Co., principally for use in connection with their gun-barrel drilling machines. The tool in question is a development of the old D or hog-nose drill which has one cutting lip only. It is carefully ground on the outside and is supplied with an oil duct through which oil at high pressure may be brought direct to cutting

edge. Referring to Fig. 1, *A* is the cutting edge, *B* the oil duct, *C* the chip groove.

In milling the latter groove it is brought directly to the center so that in this respect the drill is very free cutting as compared with the ordinary two-lip twist drill which has a central web. In the end view the shape of the chip

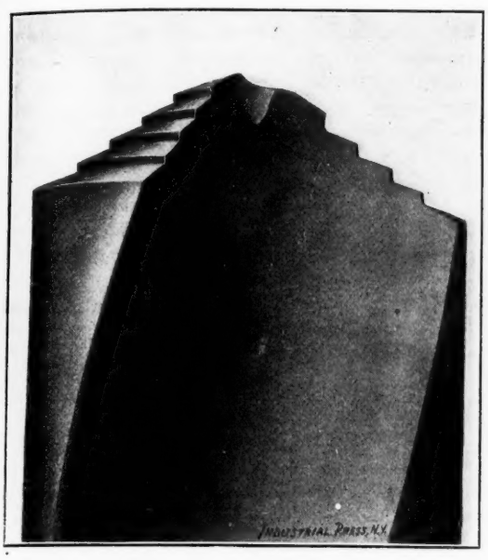


Fig. 4, Large Drill Having a Stepped Cutting Edge.

groove is clearly indicated. The cutting edge *A* is radial and the bottom of the groove touches the center line *x y*.

In sharpening the drill the high point or part first entering the work is not in the center as is usually the case in drills, but as per Fig. 1, in which *D* is a cross-section of work being drilled and *E* the high point of drill. Grinding the drill in

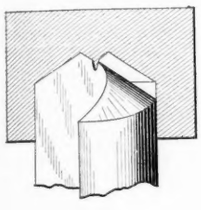


Fig. 6.

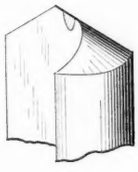


Fig. 7.

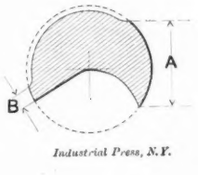


Fig. 8.

this manner is one of the reasons for its running true or straight, the teat *F* on the work acting as a support to the drill, which, owing to its periphery being partly relieved, would have a tendency to travel in a curve away from its cutting side. The piece being drilled is run at very high speed, the periphery speed at the outer diameter of the hole running as high as 130 feet per minute on machinery steel. The feed, however, is quite fine, on a 0.3-inch drill averaging .0004 inch per revolution, while on a 3-inch drill it is about .0008 inch. These figures, of course, are dependent to a great extent on the material being drilled.

These tools are made of high-grade steel and left very hard so that the fine feed has little tendency to glaze the cutting edge.

In practice the piece being drilled is held and revolved at one end by a suitable chuck on the live spindle of the machine, while the other end, which should be turned perfectly true, runs in a stationary bushing having at its outer end a hole the diameter of the drill. The drill enters the work through the bushing and is thus started perfectly true. See Fig. 2, in which *A* represents the chuck, *B* the work, *C* the bushing, *D* the support for holding the bushing, and *E* the drill.

Through the oil duct of the drill oil is forced at a pressure varying with its diameter from 150 to 200 pounds per square inch. After passing the cutting edge the oil returns to the reservoir by the chip groove *C*, Fig. 1, forcing chips along in its travel. In drills of large diameter, especially when working on tough, stringy material, the cutting edge is usually ground so as to produce a number of shavings, instead of one the full width of the cutting lip, so that no trouble is experienced in getting chips out of the way. The oil, of course, is used over and over again and with a large reservoir will be kept quite cool.

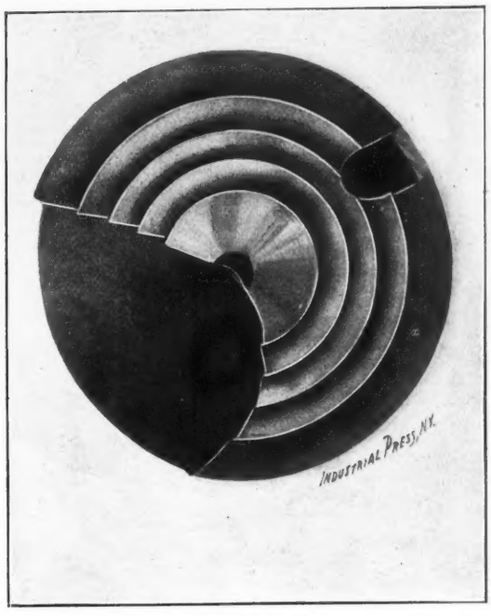


Fig. 5. End View of Fig. 4.

The drill is made up of the drill tip and shank, the tip varying in length from 4 inches to 8 inches, while the length of shank is determined by the depth of hole that is to be drilled. Fig. 3 will clearly illustrate the construction of a small, complete drill, *A* being the tip, *C* the shank, and *D* the oil duct. The shanks on small drills are made from steel tubing rolled as per cross-section *a a*. The tip is carefully fitted and soldered to the shank, which, it should be noted, is a little smaller in diameter than the tip. The shank, with oil under pressure, is very stiff.

The relief or clearance to the cutting edge of the drill, the amount the "high point" of the drill should be off center, and the number of rings on the end of the drill depend entirely upon the material that is to be drilled. For instance, on very soft stock the supporting teat should be more substantial than on hard spindle or gun steel so that it is evident that on soft stock the high point should be off center or much nearer to the outer diameter than on hard stock.

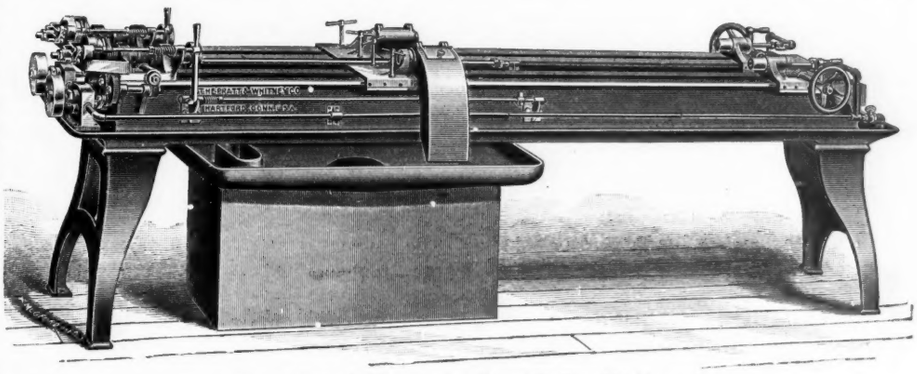


Fig. 9. Pratt & Whitney Gun Barrel Drilling Machine.

Figs. 4 and 5 are reproductions from actual photos of a 3-inch drill, and the reader will obtain a very clear idea from

same of the appearance of the tool we have described. These figures illustrate a drill ground on the end so as to produce several shavings.

The present practice in relieving the large drills is as per sketch in Fig. 8. The straight, or radial, edge is the cutting edge of the drill and the distance *B* is about ⅛ inch on a one-inch drill. The surface *A* is left of the full radius of the drill and makes a good back rest. When the drill is ground on its periphery it is made *very slightly* tapering toward the shank to free itself. As previously stated, in milling the chip

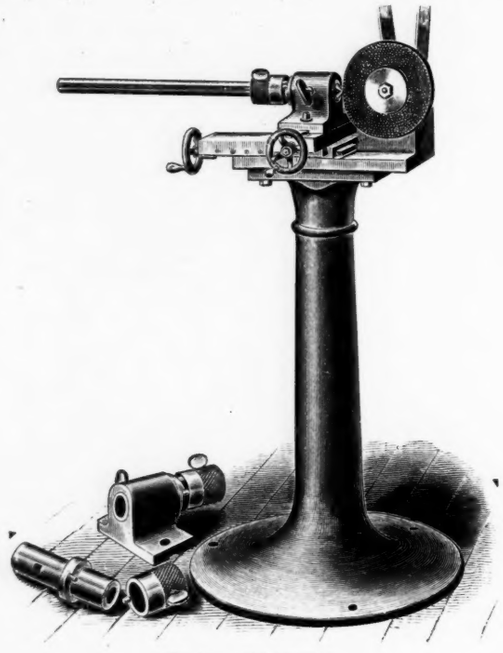


Fig. 10. Drill Grinder.

groove the cutter is brought exactly to the center of the drill. When hardening and grinding, however, the location frequently changes slightly so that the groove does not come to the center of the drill. In such cases it is necessary to grind out the lip at the point as shown in the illustrations from the photographs in Figs. 4 and 5. Generally the workman grinds this a little beyond the center, but no trouble results, as the small teat produced thereby is broken off when the bottom of the ground out place comes in contact with the end of the teat. (See sketches 6 and 7.)

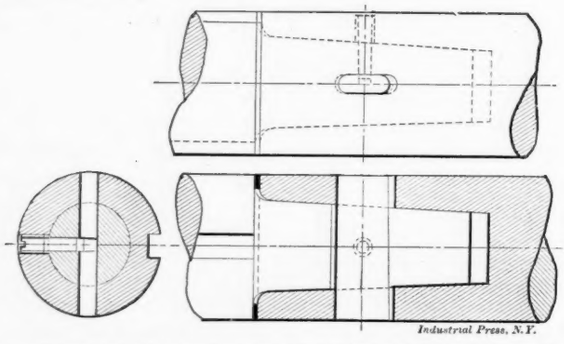


Fig. 2. Front End of Boring Bar showing Method of Attaching Boring Head.

In Fig. 9 is an engraving of one size of the gun barrel drilling machine, as built by Pratt & Whitney. The machine is double and has a horizontal bed. The heads are at the end and have mounted in them independent spindles parallel to each other. On their inner ends are chucks for securing and rotating the barrels in the adjustable rests which support, guide and control the starting of the drills, which are secured in the sliding carriages and are fed positively 38 inches by a screw having automatic stops. The screw has a variety of speeds through change gearing, to compensate for different qualities of stock to be drilled.

Two rotary pumps (one for each barrel) force oil, supplied from a tank placed underneath the machine, through a series of tubes into and through the drill. The oil lubricates the cutting lip and forces out the chips into the basin on top of the tank, where they are drained, and the strained oil returned to be pumped again.

A special grinder is employed for grinding the drills, a view of which is shown in Fig. 10. The engraving is misleading, however, since the fixture to support the drill holds the latter at an angle with the face of the wheel, instead of parallel with it, as shown. This angle is such as to give the cutting lip about the same inclination as on ordinary twist drills. The fixture for holding the drill is carried on a slide on the table of the machine. It is made to receive bushings of different diameters and the drills are held in the latter by a set screw. The bushings are free to slide and rotate in the fixture and when a drill is revolved by hand it is given a forward or backward movement through the action of a pin in its bushing, which bears on a spiral cam in the fixture. The lip of the drill thus receives the required spiral movement necessary to give it the proper clearance. When grinding a stepped drill the corner of the wheel must be used and this corner must be sharp, not rounding, so that the several cuttings will be severed from each other.

BORING LARGE GUNS.

CONTRIBUTED BY J. M. B. SCHEELE.

It is generally known among the well-informed mechanics that the introduction of built-up or hooped guns necessitated many new designs and radical changes in machine tools,

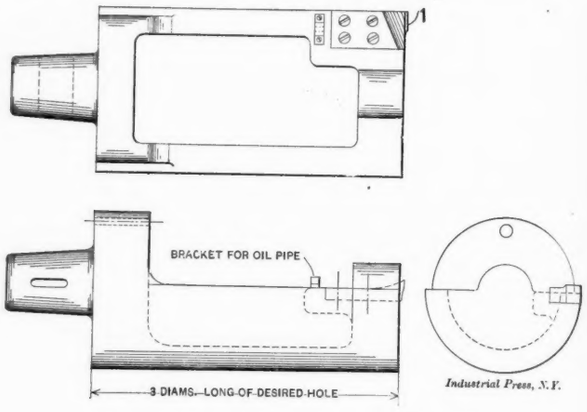


Fig. 1. Hog Nose Tool Boring Head—Cast Iron.

especially in the lathe. My intention in this article is to elucidate the methods of deep horizontal boring and reaming, and my impression is that I can convey to the minds of the readers no better idea of these operations than by considering the rough and finished boring of the tubes for the modern built-up steel guns.

These tubes, which constitute the central portion of the guns and upon which a series of hoops are shrunk, are composed of a very high quality of special oil-tempered steel. The tubes, according to requirements for the various sizes of guns usually vary in length from 20 to 50 feet with internal diameters from 6 to 30 inches for the large guns, and from 5 to 15 feet in length, with internal diameters from 3 to 6 inches, for the smaller sizes.

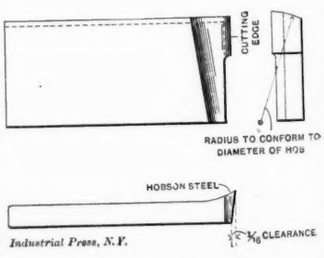


Fig. 3. Detail of the Boring Tool.

As it is primarily essential that the bore of these tubes be perfectly straight and the diameter correct and uniform, approaching mathematical accuracy, it might be of interest to point out the simplicity of design and performance of the tools with which this most important operation is performed. The forgings for the tubes as received from the steel works have a surplus amount of metal on the inside and outside, to allow for the boring and turning operations. Owing to

the length being proportionately greater than the diameter they are also, in the majority of cases, more or less warped, due to the processes of oil-tempering and annealing to which they have been subjected. After having ascertained the amount of possible warp and having investigated the concentricity of the inner and outer circumferences, the tube is centered and spotted in a special lathe designated for the purpose, preparatory to the first rough boring. The tool used in rough boring, commonly known as the hog-nosed tool and guides for the double-ended cutter bolted in the front end of the head, as shown in detail in Fig. 4.

These blocks while in position are turned off to a diameter about .005 of an inch larger than the desired bore, the idea being to force them in and thus give them a smooth and uniform bearing surface.

The cutters used are made from a very high-grade steel, ground to exact size and oilstoned to conform to the required diameters.

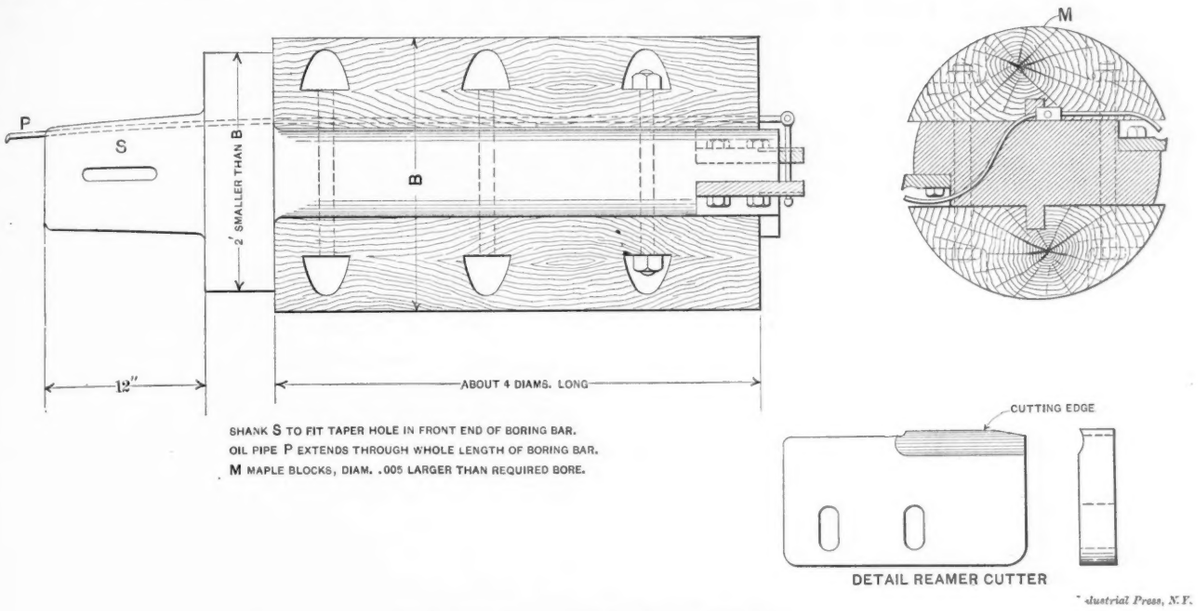

P
S
2" SMALLER THAN B
B
12"
ABOUT 4 DIAMS. LONG
M
CUTTING EDGE
DETAIL REAMER CUTTER
SHANK S TO FIT TAPER HOLE IN FRONT END OF BORING BAR.
OIL PIPE P EXTENDS THROUGH WHOLE LENGTH OF BORING BAR.
M MAPLE BLOCKS, DIAM. .005 LARGER THAN REQUIRED BORE.
Industrial Press, N.Y.

Fig. 4. Tool for Finishing and Reaming the Hole.

represented in Fig. 1, consists of a semi-circular cast-iron body provided with a shank on one end secured to the front end of the boring bar (which has a taper and flat keyhole to receive it, Fig. 2), and a cutter clamped on the forward end, the material of which is high-grade tool steel, very carefully tempered. The cutter is made with the edge cutting square on the forward end, and with the lip turned slightly upward, in order to roll the chips backward to free it, as indicated in Fig. 3.

Provision is made to throw a jet of a lubricating mixture in front of the tools during the operations of boring, reaming and finishing, the lubricant serving to diminish the friction on the tools as well as to preserve their temper. This is accomplished by a rotary oil pump which conveys a continuous stream of oil by means of two wrought-iron pipes connected with an intermediate flexible metallic hose which travels with the boring bar and is attached to a fixed pipe which passes through the interior of the boring bar, terminating at the end of the cutting tools. The pump is provided with different changes of speed.

Although this tool, because of its design, is capable of removing a considerable quantity of metal, it has proven most practical not to allow it (though this is seldom required) to remove more than from 0.2 to 0.5 inch of metal on the side, leaving approximately 0.1 inch to be removed by the reaming and finishing tool in the succeeding operations.

The rough boring being completed, the hog-nosed tool is removed and the tool shown in Fig. 4, for finishing and reaming, is inserted in its place. This is made of a cast-iron body about four diameters in length, to which are bolted two semi-circular blocks of carefully-selected and well-seasoned oak or maple that have been previously submerged for a long period in a bath of lard oil and that serve as

To insure a perfect alignment for the tool before commencing the actual reaming, it is good practice to counterbore the tubes from 3 to 6 inches. The method of supplying oil while reaming is the same as employed in the operation of rough boring. It may be of interest to note that, with the same cutting speed, the feed may be from four to five times that of the hog-nosed feed by giving the cutter a taper in front of about 1 to 10, with a straight cutting edge 1 inch long on the side. Such construction also serves to maintain the size in case the forward part of the cutter becomes slightly worn.

Multiple cutter wood reamers, shown in Figs. 5 and 6, have been successfully used for bores of from 3 to 6 inches calibers, for lengths varying from 5 to 15 feet. Greater feed can be obtained from tools thus constructed, and consequently con-

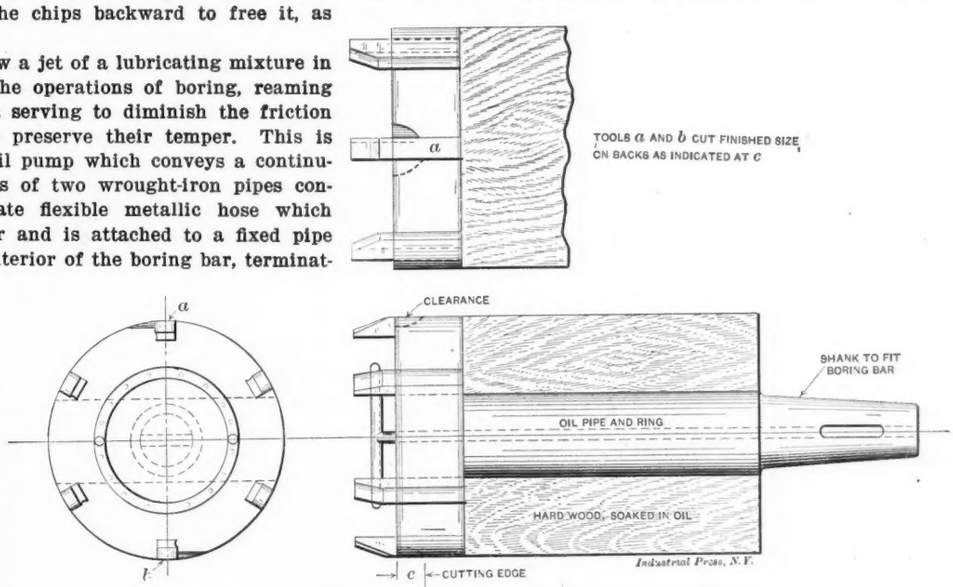


Fig. 5. Boring Tool for Holes from three to six inches in diameter.

siderable time is saved by this device. It must be borne in mind, however, that in tubes of great length, in which there is an unequal distribution of stock on the interior, this tool has a tendency to run out of its true axis, thus leaving an unsymmetrical bore. This difficulty is obviated and a perfect and uniform bore obtained by the use of the previously described hog-nosed tool and wood-lined reamer, although some time is sacrificed owing to the reduced feeds at which they have to be run compared with the feeds obtainable with a multiple cutter wood reamer.

In boring guns lathes are employed which are specially designed for the purpose. Nevertheless, if such a machine is not available, for short lengths and small bores, it is advisable to use the old and well-known method of attaching to the cross-slide of a common lathe of suitable length of bed a fixed support or bracket having a bore to receive a number of bushes, the bores of which correspond with the varying diameters of boring bars. The hub of this support or bracket has one side split to enable it to be tightened by a bolt, in order to retain and grip the bushing which is likewise split for the purpose of gripping the boring bar. The boring and reaming tools, Figs. 5 and 6, previously described, are particularly applicable in this case.

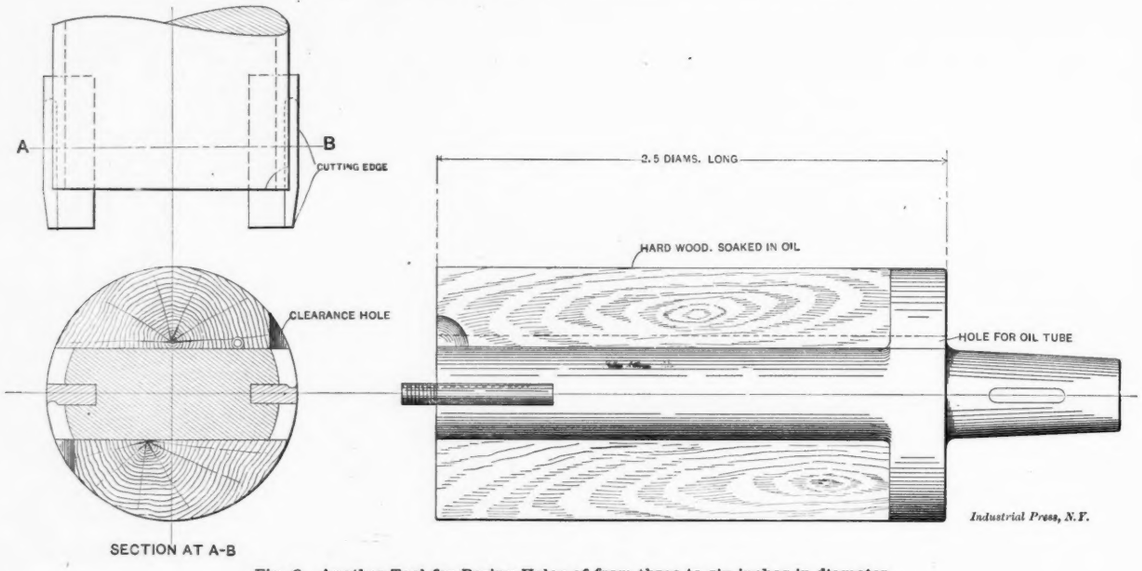


Fig. 6. Another Tool for Boring Holes of from three to six inches in diameter.

After having determined the required feed and set the lathe in motion, the carriage will serve to translate the bar in the usual manner. The other functions are performed in the ordinary way and are too obvious for further explanation.

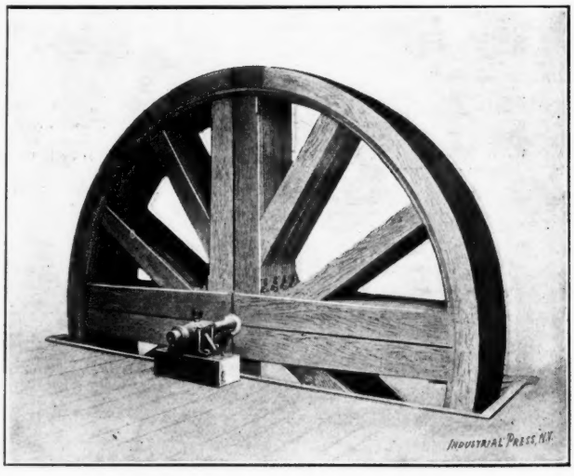
* * *

EMERY COATED TOOLS.

The use of emery tools has been limited because the material does not lend itself readily to shaping, being practically confined to grinding surfaces of simple forms. The galvanic process invented by Joseph Rieder, of Leipzig, however, allows us to make use of any kind of emery powder, and to arrange it in various shapes, so that we are presented with a new style of emery tool. Rieder is known as the inventor of the electro-engraving process, whose characteristic feature is a machine which returns the plaster negative to its position with mathematical accuracy, so that the galvanic etching, which has to be interrupted several times a minute to secure uniform electrolytic action, practically remains continuous. In order to fix the emery sand on the tools referred to above, he first coats the emery with a varnish obtained by dissolving wax or paraffin in benzine. Graphite will adhere to the grains when they have been treated thus, and in this way the emery surface is made electrically conductive. The tool, which is a disk, is placed in the sulphate of copper bath, and the prepared sand dropped on it. Each grain will become imbedded in a coating of copper, and the grains will thus be fixed just as gems have been mounted for some time by means of a galvanoplastic process. The sand can also be treated with a glycerine paste, which is then applied to the surface to be covered with emery. As soon as a thin film of copper has settled on the steel, the glycerine is washed off with hot water, and the copper film is afterward thickened in the bath. In this way emery tools are obtained, which are said to wear very well. Their disadvantage is that they do not cut deeply, because the interstices are filled up. But such disks can be revolved at a much higher rate than we could venture to adopt in the case of an ordinary emery wheel of the same dimensions. Another advantage is that tools of this kind may be constructed in almost any shape.—ENGINEERING.

LARGE WOOD PULLEY.

The pulley illustrated herewith is one of the largest all-wood belt-transmission wheels now running in the United States. It is 16 feet in diameter, the face 31 inches wide, the bore of the hub 8¼ inches and the exact weight of the pulley 13,440 pounds. The material throughout is Southern Indiana oak and the pulley is built in quarters. The arrangement of the arms is interesting, making a neat as well as a very rigid construction. There are four main arms, and from near the base of each smaller arms, in the form of braces, extend on each side to the rim. The photograph is inaccurate in that it does not show the full number of compression bolts at the hub. The small object barely visible on top of the bearing is a four-inch model pulley of the same design as the large one. The pulley was built for the Peters Lumber and Shingle Co., Benton Harbor, Mich., by the Reeves Pulley Co., Columbus, Ind., and was shipped in six weeks from the time the order was placed.



Sixteen-foot Wooden Transmission Pulley.

RADIAL MACHINE BEARINGS.

THE INFLUENCE OF DESIGN UPON THEIR WEARING QUALITIES.

J. RICHARDS.

The term "radial bearing" is in the present case employed to denote machine bearings in which the surfaces are transverse or radial to the axis of rotation, such as collars and flat step bearings. That such a simple matter presents material for discussion may be questioned; but in practice there is abundant room for comment and criticism—perhaps for some useful hints to those whose attention has not been called to the subject. It is purely a feature of construction and one that with a few exceptions seems to have escaped the exhaustive treatment bestowed at this day on everything that permits dissertation.

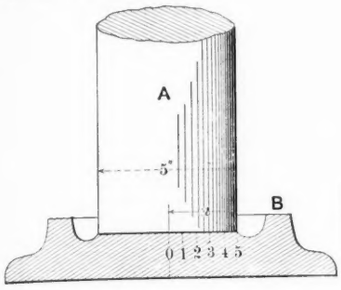


Fig. 1.

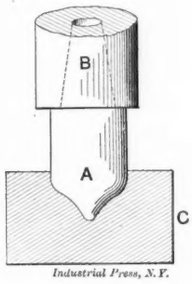


Fig. 2.

In all kinds of machinery, or, as we may say, in the case of all shafts and spindles, there are two kinds of bearings—one kind parallel to the axis of rotation to resist lateral strain and the other normal to the axis to resist longitudinal strain. The forces to be resisted vary greatly, but sometimes, as in the case of screw propeller shafts, they are equal, the transverse strain being translated into longitudinal thrust. In many cases, drilling machine spindles, for one example, the longitudinal thrust is the principal strain; and vertical shafts frequently bear heavy loads, resting on step bearings, which have long presented a problem to designers of machinery—furnishing one of a few cases where the operative conditions fail to harmonize.

Considering the wear and heating of step bearings to be functions of speed and pressure on their surfaces, these are opposing factors, so to speak, which in the case of step bearings traverse each other. It is well known that in the case

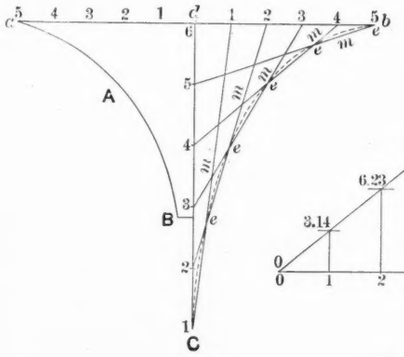


Fig. 6.

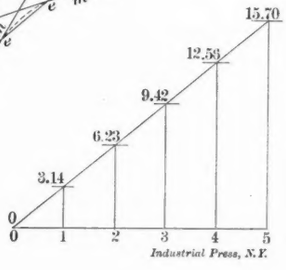


Fig. 7.

of all bearings, flat or cylindrical, when the surfaces move at uniform velocity there is no difficulty to maintain them within reasonable velocities so long as the common rules of good construction are adhered to. Even the want of uniform pressure in cylindrical bearings is not an impediment to their maintenance; but as soon as the bearing surfaces become radial, or oblique to the axis of rotation, and the pressure is considerable, heat and wear begin.

Down to recent times, and where speed and pressure were much less a feature of machine operation, end thrust or step bearings were successfully made of very hard material and flooded with oil. This answered very well up to a limit where abrasive wear set in. Then such bearings failed and frequently "froze," as it was called, one face being welded to the other, supposedly the result of the lubricant being expelled and a high degree of heat instantly generated. The maintenance of such bearings depended upon a complete absence of wear which occuring, would eliminate uniform contact.

To illustrate the difficulty respecting velocity, suppose that the shaft *A* in Fig. 1, 5 inches in diameter, rests on a flat step *B* and that the radius *a* is divided into five equal parts, as indicated by numerals below, the velocities at these points will, as in Fig. 6, increase from 0 to 15.70 in a radius of 2½ inches or from 0 to 3.14 in a shaft 1 inch in diameter. Considering velocity as one and perhaps the principal cause of wear, it is easy to perceive what a contradictory set of conditions is here set up and how impossible it is to compensate wear of the surfaces. If pressure, the other factor of wear, be added, it is plain that quick destruction must follow if abrasion or even the slightest reduction of the surfaces takes place. Reverting again to Fig. 1 and supposing the material to be inelastic, the slightest wear, even the thousandth of an inch, in the outer zone, would shift the whole pressure to the remaining four and so on to the center, where the intensity of pressure would cause more rapid wear, producing curved surfaces. This is what takes place. The writer when a young man enjoyed the distinction of being a shop foreman in an establishment where a portion of the equipment consisted of ten or more small lathes for turning tool handles, that ran at speeds from 1,500 to 2,500 revolutions per minute.

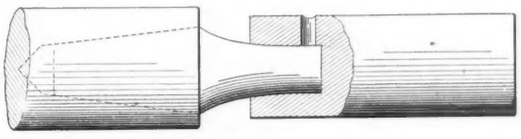


Fig.3

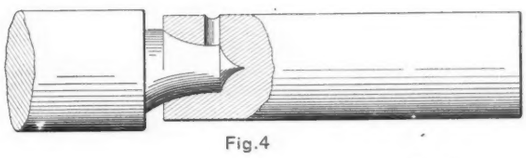


Fig.4

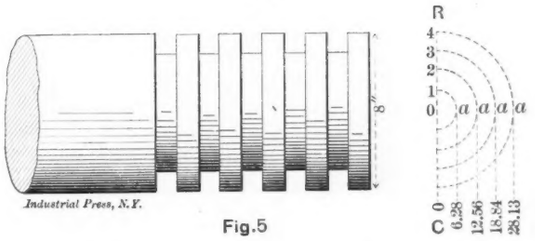


Fig.5

The hardwood blanks were put in the lathes while in motion and were screwed up with about all the force that could be applied on hand wheels from eight to twelve inches in diameter, to drive the claw centers into the work. The pressure required was from 500 to 1,000 pounds. The wear of the spindle thrust bearings was rapid and they required continual attention, with new points once a month at least. These thrust bearings, which were also the rear supports for the spindles, were made at first as in Fig. 3, of the finest tool steel and "salt hardened." Spare centers were kept on hand, made to uniform size and, as remarked, it required but a short time to wear them into a form like that in Fig. 4, which is sketched from memory. We were repeating Mr. Schiele's experiment, which was to fasten a blunt cylindrical bar of chalk *A* into a drilling spindle *B* and bore this down into a solid block of chalk *C*, as in Fig. 2, by abrasive action. The result was always the same, the form being something as shown. From this he developed the assumed theory that compensation for wear in a bearing of any kind should be at all points in proportion to the velocity at which surfaces move at these points. This leads to the parabolic curve illustrated in Fig. 6, generated as follows:

Draw the lines *a b* and *c d*, the first representing the extreme diameter of the shaft or spindle and *c d* its axis. Set off on *a b* a number of spaces, 1, 2, 3, 4, 5, and on *c d* other equal spaces numbered to correspond and to suit the desired length

of the bearing. Then join these spaces by the lines m and the intersections e will be in the path of the curve A, as shown on the left.

The wear of radial bearings into a curved form is a convincing clue to their true form, or rather to their best form, because it is evident that compensation for both pressure and velocity is not possible. They are in opposition, both following the curve in Fig. 6 in the same direction in similar degree, and a compromise would demand some impracticable form difficult to attain in common practice.

When marine screw propellers came into use various means of resisting the end thrust of the shafts were tried. There were hardened steel bearings flooded with oil, various kinds of compositions and alloys, surfaces of large and small area, hydraulic steps and so on; but natural selection in time brought a series of shallow collars that ended the difficulty. Whether this device was blundered upon by experiment or was the result of "natural selection" it is hard to determine now. The expedient was adopted fifty years ago by Mr. Boyden to sustain the large Fourneyron turbine wheels at Lowell, Mass., and it had been employed, no doubt, long before in exceptional cases. It is a simple, and is no doubt the final, means of resisting the thrust of shafts, being in fact a near approach harmonizing velocity and pressure of the bearing surfaces. For example, if in Fig. 5 a shaft 8 inches diameter is provided with five thrust collars 1 inch deep, the sum of the bearing surface will be $21.99 \times 5 = 109.95$ inches, or more than twice the area of the shaft's cross-section, and the variation of speed between the outer and inner diameters of the collars will be within 25 per cent of uniformity and the mean variation half as much, or quite within the conditions of maintenance, with copious lubrication. Such bearings, as everyone knows, have to sustain for weeks or months even, without cessation, a thrust of thousands of horse power, seldom causing any difficulty, and furnish, as before remarked, a practical solution of the problem of radial bearing surfaces.

The unnatural conditions under which radial bearing surfaces have to operate are mainly responsible for what Mr. Thompson, of the Buckeye Engine Co., calls the "rotary engine malady," which has cost millions of capital and much lost effort. I have yet the first case to meet with where an inventor and designer of a rotary engine has set out with a recognition of the want of uniform velocity in the bearing surfaces that have to be kept steam-tight. The evil of radial bearing surfaces crops out in many unsuspected places, many in which it would be avoidable if the action and results were better known. A stipulation in specifications for machinery requiring that the velocity between all bearing surfaces should be within a certain per cent of uniformity, would soon settle this matter. This would be reasonable and practicable; but it requires "starting."

* * *

INDUSTRIAL BETTERMENT.

AN INTERESTING GROUP OF VIEWS FROM A CLEVELAND PLANT.

During the past two years the Cleveland Twist Drill Co., Cleveland, O., have added a new building to their factory, have installed one of the most complete power and electrical transmission plants with which we are acquainted, and have built spacious offices that are models of convenience. While engaged in making these improvements, the company also considered features that would lend to the comfort and convenience of their employees, which have been successfully introduced, and while much pride is taken in the remodeled factory, even more satisfaction is felt by the management in these industrial improvements.

The interesting collection of views on the opposite page shows what some of these improvements are. Perhaps quite as important as anything is that the workmen have a clean and convenient place for keeping the clothes worn when going to and from the factory and for storing any possessions they wish to keep in safety during the working hours. In Fig. 1 is a view of individual metal lockers that have been introduced throughout the factory. They have been found so desirable that individual lockers have also been adopted for the office force, which, however, are of wood instead of metal, to be in keeping with the finish used in the offices. Each workman has a key to his own locker which will not fit any other locker, so that his clothing is safe from molestation; and the fact that the walls of the lockers are made of a heavy open wire mesh insures ample ventilation and a thoroughly wholesome condition. Fig. 2 shows conditions as they were before the introduction of these lockers, and needs no comment.

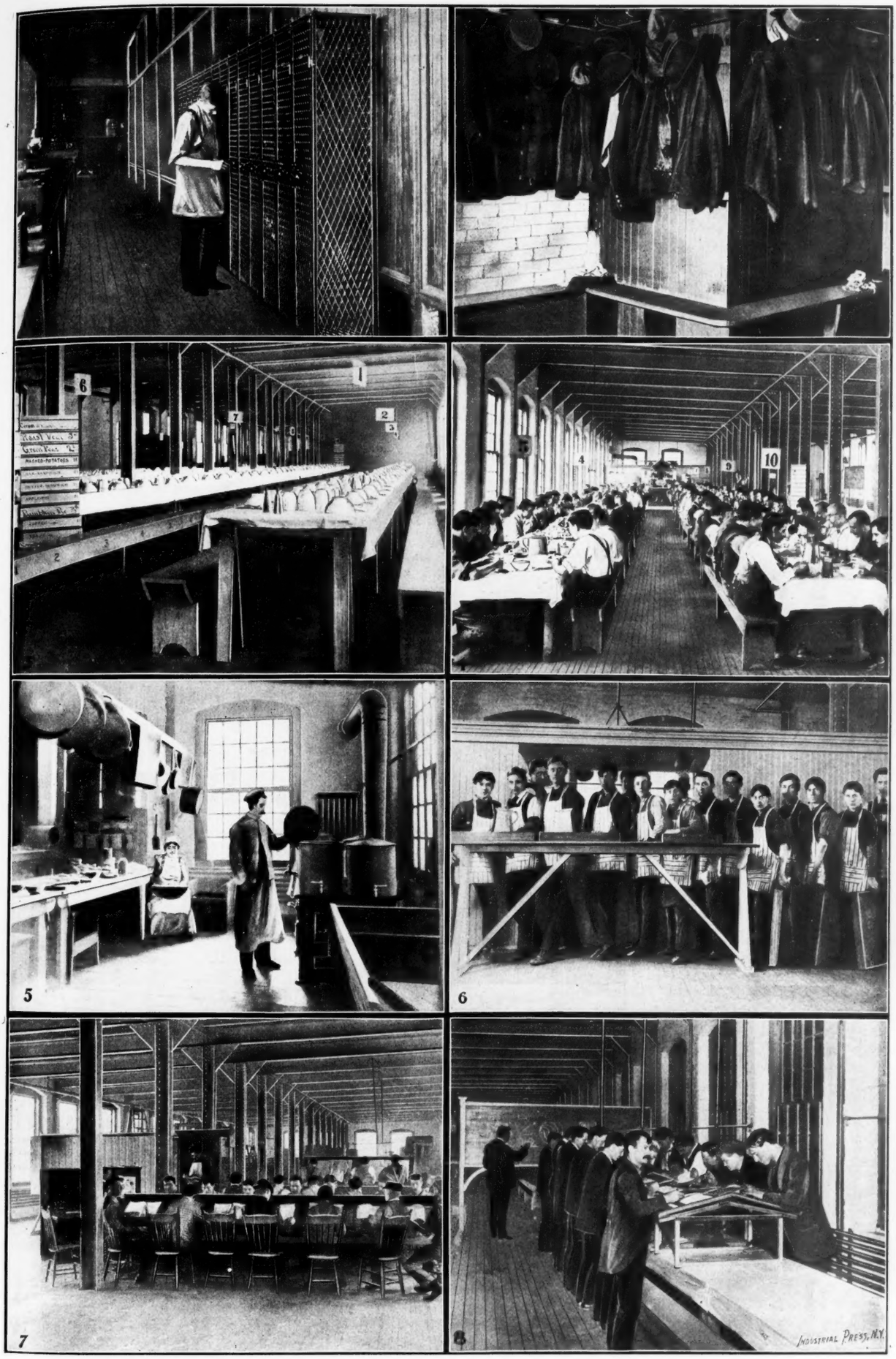
Figs. 3 to 6 inclusive illustrate the arrangements that have been adopted to provide a comfortable dinner or lunch for any of the employees desiring it during the noon hour. Fig. 3 shows the tables set for dinner. In the foreground at the left is the bill of fare for the day when the photograph was taken, which is typical of the menu provided every day. The "contents" are as follows: Cream of barley soup, two cents; roast veal, five cents; green peas, two cents; mashed potato, one cent; sandwiches, two cents; pie, three cents; coffee or tea, one cent; crackers, one cent. For seventeen cents, therefore, a person can be served with each kind of food on the bill of fare. A hearty dinner can easily be obtained for fifteen cents and a good lunch for ten cents, or less. If preferred, an employee can bring a cold lunch with him and simply order what warm food or drink he would like to go with it.

The tables are capable of seating 180 at dinner at one time and it will be noticed in Fig. 3 that there are cards suspended over the tables bearing numbers, that divide the tables into sections. This is for convenience in arranging the service at the tables. A certain number of persons are assigned to each section and of these certain ones are appointed from each section to act as waiters for a length of time decided upon, as one or two weeks. After they have served their time, others are appointed, etc., in rotation. The waiters are excused from their work in the factory fifteen minutes before closing time and they repair to the dining room to set the tables. In Fig. 6 the waiters are shown lined up, with their trays, to receive food from the cook.

By this method the expenses and annoyances incident to the employment of regular waiters are avoided. An expert cook and assistant cook are employed, and the price charged for the food is just enough to cover the cost of the food itself, the other expenses being borne by the management. Fig. 4 is from a photograph taken during the dinner hour, and Fig. 5 shows a model kitchen.

On the same floor with the dining room is a large space fitted up as a reading room. Files of the leading technical and general magazines are supplied and there are also copies of the leading Cleveland daily papers. This room is open during the noon hour and affords a comfortable meeting place. There is also a piano, to help brighten the hour, and music and song are indulged in at pleasure. A view of this room appears in Fig. 7, and in the center of the illustration will be noticed a tall case which is supplied with books by the Public Library of Cleveland. The case is filled with a collection of new books at regular intervals and employees may here draw out books desired by themselves or their families, without the trouble of going to the main library building for them.

In Fig. 8 is an illustration from a photograph of an evening drawing school in the same building. Classes are held two nights a week in English, mathematics, and mechanical drawing. All the expense of the night classes is borne by the company, who employ first-class teachers, and the classes are open to any employee who chooses to attend. There is also a benefit association among the employees which is in the nature of an accident insurance, each employee contributing a certain amount to the association each pay day until the funds reach a certain stated amount, when the dues are omitted until, through an accident or the sickness of some employee, the funds are reduced and the dues are again paid in until the original amount is made good. Among other innovations in connection with this scheme of industrial betterment is a suggestion box, and many valuable suggestions have come by means of the hints given by employees.



Figs. 1 and 2. The New and the Old. Fig. 3. Tables set for Dinner. Fig. 4. At Dinner. Fig. 5. Where the Cook holds forth. Fig. 6. The Waiters are ready. Fig. 7. During the Noon Hour. Fig. 8. Evening Class in Drawing.

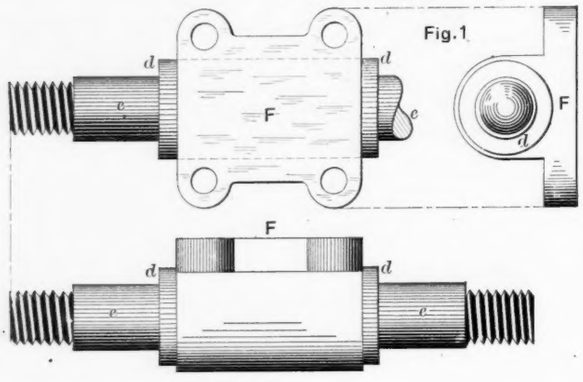
VIEWS AT THE WORKS OF THE CLEVELAND TWIST DRILL COMPANY

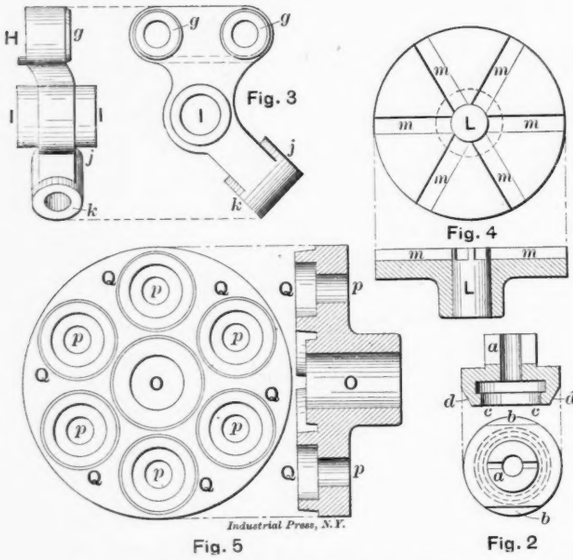
TOOLS FOR INTERCHANGEABLE MANUFACTURING.—6.

MILLING FIXTURES FOR ACCURATE WORK.

JOSEPH VINCENT WOODWORTH.

We are now about to take up a class of milling fixtures of a different type from those described in the last article, in that they are more intricate and are also capable of producing more accurate results. When designing these tools there are three questions to be considered: First, Are the parts which are to be machined required in large quantities? Second, Must they be finished very accurately, so as to be interchangeable, and lastly, Can the parts be handled and finished to the best advantage on the milling machine?





Sketches of Pieces for which the Jigs Illustrated in this Article were Designed.

The first two questions can be answered in very short order, but in deciding the answer to the last one, the knowledge and skill of the designer—who is often the constructor as well—is put to the test. If it is decided that the milling machine is most suitable for the work, the following points must then be considered, after the shape and type of the fixture have been determined: The surfaces by which the pieces are to be located; the devices for fastening the work, and the most practical way of presenting the surfaces to be machined to the cutter or cutters, as the case may be.

As types of the most reliable class of milling machine fixtures for duplicating small and medium machine parts there are here shown five examples which are well designed for the particular pieces of work for which they are intended. The devices also are suggested, in that many of their features can be so modified as to be applicable to work of other kinds. Methods for constructing the fixtures will be described, explaining how they can be produced within a reasonable length of time and a moderate expense.

Jig for the First Piece of Work.

The first fixture is the one shown in the three views of Fig. 6, used for facing the flat surface of the work in Fig. 1. The finishing of the ends of the piece is accomplished in the lathe, the parts *e e*, *d d* and the threaded portions being interchangeable. The fixture, Fig. 6, for facing the flat surface *F* true with the turned portions of the work is of few parts, and holds the work rigidly. As the method of construction is not very intricate, and can be understood from the illustrations, a slight description will suffice. The fixture proper consists of the body casting *G*, the standards *H* between which the work is located, the back projection *I*, for the fastening and locating screws *N N* and *O O*, respectively, and the two clamping lids *J J*. The lid clamping screws *L L* are fastened in a slot in the standards, as shown in the face view, by means of a Stubs steel pin, so they may be fastened and released as rapidly as possible. The lids *J J* are hinged as shown at *K*. The locating screws *O O* are of tool steel and are reduced at the ends as shown at *P*, in the end view, and hardened and equipped with jam nuts. The tongue *T* is let into a slot in the bottom of body casting *G* so as to be perfectly in line with the turned portion of the work when within the fixture.

The boring of the standards and lids to size, and the facing of the surfaces *M M* so that the work will fit between them snugly, is accomplished in the following manner: The base is first planed, and the body casting strapped to an angle plate on the drill-press table. A boring bar is then used, with the end running in a bushing in the table, and the holes are bored and the shoulders faced. The two screws *N N* for forcing the work against the two locating screws *O O* have knurled heads with a spanner hole as shown, are threaded to screw freely in the tapped holes and are also equipped with jam nuts.

When using this fixture it is clamped on the miller table with the tongue *T* in the slot nearest the spindle. The two lids *J J* are then thrown back, and the work located as shown, first tightening the lids, and then forcing the work against the two locating screws *O O* by means of the knurled head screws *N N* and fastening the nuts to keep them tightly against the work. The cross feed of the miller table is then clamped so that the cutter will remove the amount of stock required, and the face is milled, using a large face cutter and running it so that the cut will be downward, thereby taking the strain off the fastening screws *N N*, and keeping the work against the ends of the locating screws *O O*. The facing of work of this class by fixtures of the type shown can be accomplished to a greater degree of interchangeability and in less time than by any means known to the writer.

Jig for Use in Milling the Second Piece.

In Fig. 7 we have a milling fixture of a more intricate type, and one which for rapid locating, fastening, and releasing of the work when finished, would be hard to beat, as one turn of a screw fastens or releases, as required. This fixture is constructed for the accommodation of two pieces at a time, and could, if required, be constructed for twelve on the same principle. The fixture was designed for milling work of the shape shown in Fig. 2. The piece was of machine steel and was finished all but the milling in the turret lathe, and was used as a part of an electric cloth-cutting machine which was being manufactured in large numbers. The milling consisted of a slot through the stem at *a*, and a flat at either side of the largest circular portion, as shown at *b b*.

The fixture consists of two castings *P* and *E*, and spring chuck devices, in which *I I* are tool steel pieces screwing into the casting *E* and carrying the spring jaws *K*. These jaws are forced out against the work by the expanders *L L*, which screw in threaded holes in *I I*. The one point in the construction of this fixture most worthy of a detailed description is the manner of finishing the locating depressions *F F* in the part *E*. This part is of cast iron with a projecting lug at *M*, which is used when finished as a gage for setting the three cutters which mill the work. This cast-iron block is first planed on all sides, and one side *N* finished dovetail to fit tightly into the dovetailed channel milled in the body casting *P*. This channel, by the way, was milled and the front of the casting faced after the base had been finished and the groove for the tongue was milled, on the machine on which the fixture was to be used, to guard against inaccuracy.

The block *E* was driven into this channel and fastened by two screws, shown at *R*. The position of the centers for the

locating depressions *F F*, *F F*, were then located so as to be dead in line with each other by the button method described in a previous article. The depressions were finished and the holes bored and threaded at the back by strapping the block *E* on the lathe faceplate, truing the buttons, boring the holes, finishing the formed depression to exactly the shape and depth by means of a forming tool, and then reversing the work and enlarging and finishing the holes at the back, as shown.

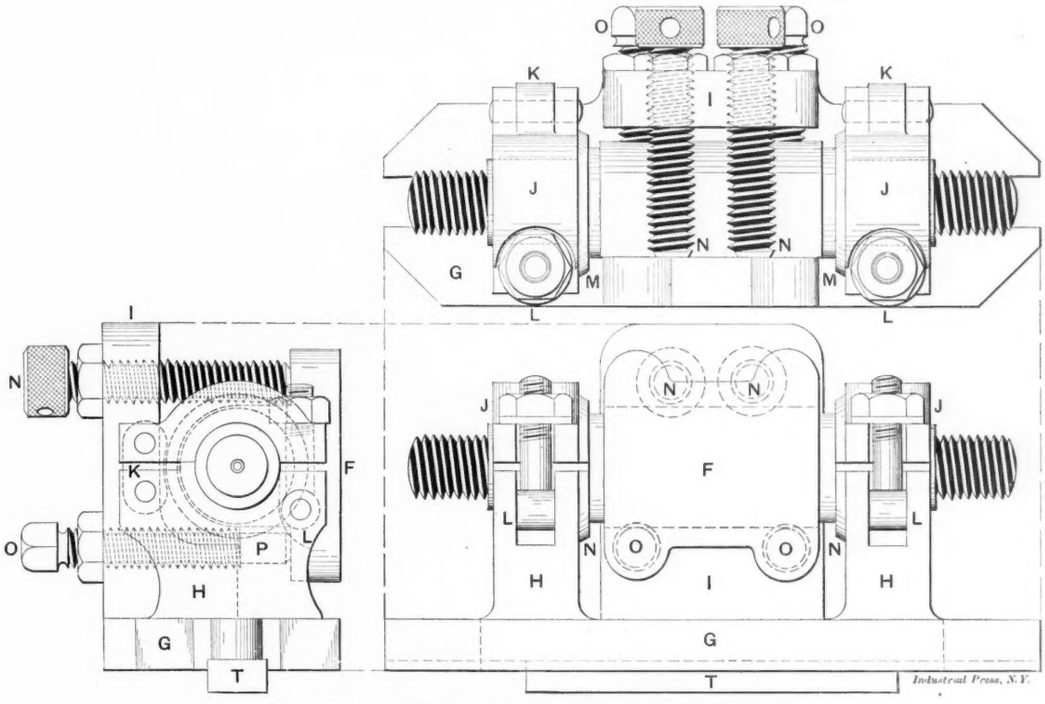


Fig. 6. Fixture for Face Milling the Flat Surface of the Work shown in Fig. 1.

When the fixture is in use, the work is held down on the locating face *F F* by hand and the expander given a turn by the handle *J*. This causes the spring chuck *K* to grip the work and draw it down on the locating face. The cutters are then set by the gage *M*, and the work milled.

Description of Fixture for the Third Piece.

In Fig. 3 are two views of a piece which is an ideal job for the milling machine. It is a cast-iron spindle bracket, and the milling operation consists of facing the fronts and backs of the two bosses and finishing the projecting rib *H* at a certain distance from center of hole *I* and at a right angle with the hole *k*. Before milling the hole *I* is bored and one side of the hub faced in the turret lathe. The opposite side is then faced and the two holes drilled through *g g* and one through *k*. The side *j* is faced in a special jig and all points machined are interchangeable.

The milling fixture is shown in Fig. 8. It is designed to hold two pieces of work at once, and can be constructed for the accommodation of a dozen, if desired. One casting *A* is all that is required for this fixture, and is in the shape of an angle plate with projecting bosses at the front and back at *B B*, as surfacing points for the work, and four projecting lugs on the face, of which *E E* are for the locating points and *D D* for the fastening screws. For clamping the work in position a device is used which allows the work to be fastened or removed with the greatest rapidity. It is shown clearly in the sectional view of the fixture, and consists of a stud *M* of tool steel, which is turned to fit nicely the hole *I* in the work and *L* in the fixture. It is of the same diameter its entire length and is threaded at the end *P* for the nut *S*, and reduced as shown in *N* to admit the clamping washer *Q*. This washer is of tool steel and is knurled on the outside so it can be easily removed, and has a section cut out as shown for slipping it into the reduced channel *N* of the stud *M*. The locating faces of the lugs *E E* are faced at right angles with the stud *M*, so that when the faced portion *J* of the work is forced against the locating face it will rest perfectly flat and bear all over. The fastening screws *U U* are reduced at the ends *W W*, ending in a square shoulder for the washers *V V*. The head of the clamping stud *M* is milled with a flat on two sides for a wrench.

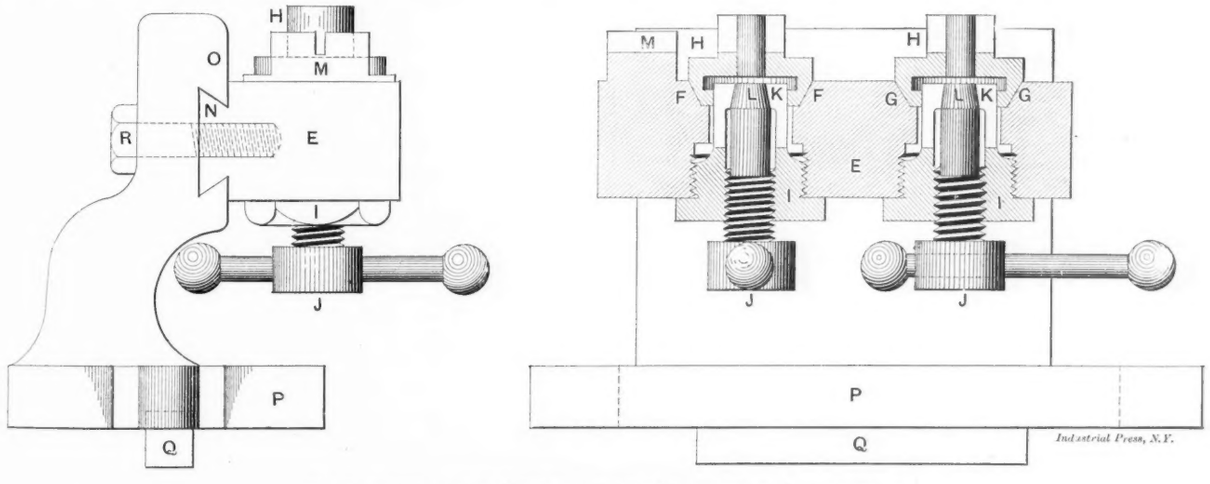


Fig. 7. Fixture with Spring Clamp for Holding the Work shown in Fig. 2.

When in use the fixture is clamped to the miller table with

the tongue *C* in the central slot. The nuts *P* of the clamping studs are then loosened, the work slipped on as shown, the clamping washers *Q Q* located and the nuts *P* tightened by using wrenches on them and on the end *O O* of the studs. The

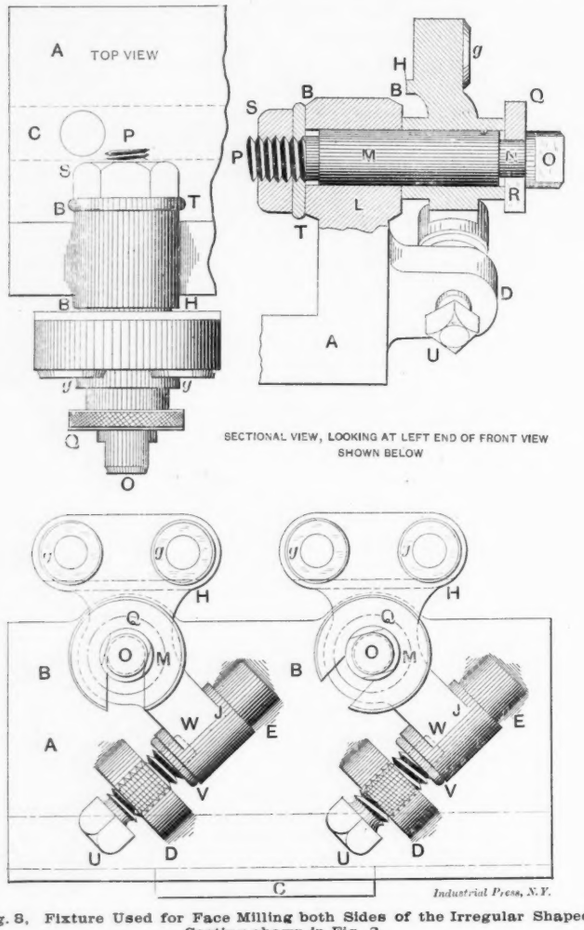


Fig. 8, Fixture Used for Face Milling both Sides of the Irregular Shaped Casting shown in Fig. 3.

work is then forced against the locating lugs *E E* by the setscrews *U U*, and milled as shown by setting a pair of straddle mills for the proper depth of cut and clamping the cross feed of the miller table. To remove the work all that is required is to loosen the setscrews *U U* and the nuts *P*, slip off the washers *Q Q*, and remove the work. The rapidity with which this fixture can be operated and the perfect interchangeability of the work produced is surprising. The device shown for clamping the work is far superior to the usual methods adopted.

Indexing Milling Fixtures for Pieces Figs. 4 and 5.

As there is a large variety of circular-shaped machine parts to be milled at different points regularly spaced, we show in the last two illustrations two types of indexing milling fixtures in which simple means are used for the attainment of the results indicated in the sketches of pieces shown in Figs. 4 and 5. The first of the two fixtures, the one shown in two views in Fig. 9, is used for milling the six equally-spaced channels *M* in the disk, Fig. 4. The castings for these parts are finished all over in the turret lathe to the shape shown, and are then milled two at a time on the fixture, Fig. 9. The illustrations show a plan and cross-section view respectively, and as the design and method of construction can be understood from them, very little description is necessary. *A* is the fixture proper, the work being located centrally on the studs *E E*, which are let into the base and located for height on the faced surfaces *C C*, as shown in the cross section. The holes in which the studs *E E* are located are bored sufficiently large to give clearance for the hubs of the work, as shown at *D*. The high projecting lugs *B B*, *B B* are surfaced so as to allow the clamps *N N N N*, two to each part, to clamp the work securely. The indexing device is shown in the plan view and is self-explanatory. The projecting lug at the right end of the work has a slot milled through it in a central line with the central locating studs *E E*, and to the depth required, thus serving as a gage for the depth of cut.

When in use the work is located and fastened as shown, only that the indexing pins are out. A cut is then taken down through both parts, as shown by the arrows, to *X X*. The table is then run back, the clamps slacked and the work moved until the index pins *H H* enter the channels just milled. Tightening the screw *J* of each to hold it securely, the cutter is run through again, and the operation repeated. The work is then removed by loosening the clamp bolts *O* and sliding the clamps back, provision being made for this by slotting the bolt holes in the clamps, as shown at *Q Q* in the cross section. By changing the location of the indexing device work may be milled with any number of slots or grooves, in fact there is an inexhaustible variety of work for which fixtures of this design can be adapted with the best results.

Fig. 10 shows two views of a fixture, the use of which demonstrates how work which is very often produced on jigs on the drill press may be machined in a better manner by the use of simple fixtures on the milling machine. The fixture is used for counterboring and facing the six bosses of the spindle

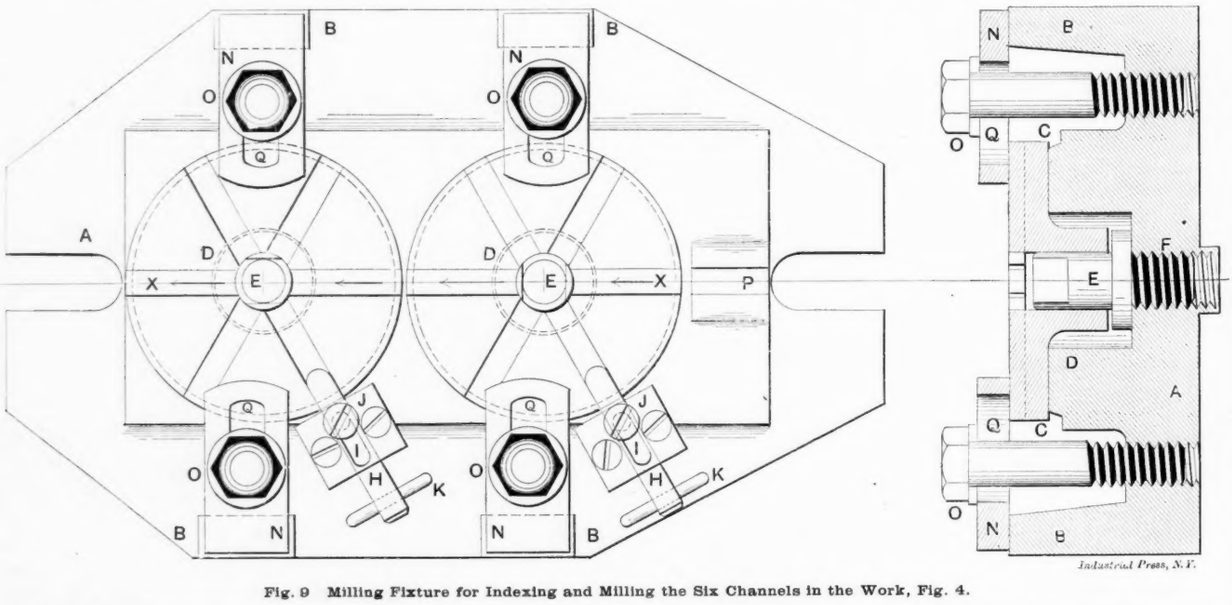


Fig. 9 Milling Fixture for Indexing and Milling the Six Channels in the Work, Fig. 4.

disk casting, shown in two views in Fig. 5. The points previously machined are the hole *O*, the six holes marked *p*, and the two hubs, all being finished to interchange. The fixture consists of the angle plate *A*, which has a projecting hub on

either side at *D* and *B*, the central locating stud and the indexing pin *O*. After the angle plate is planed on the bottom it is fastened on a shop angle plate on the lathe faceplate, and the hub *D* faced. A hole is then bored straight through the center of the hubs and reamed to size and counterbored to the diameter and depth shown in the sectional view, for clearance for the hub *F* of the work. It is then transferred to the planer where the hub *B* is faced and the channel let in for the tongue. The central locating stud is then finished so as to shoulder at *H*, and reduced and threaded at the back end for the washer *K* and the jam nuts *L L*, so as to revolve freely and without play within the fixture. The fixture is now drilled for two hardened steel bushings, one at *R* for the index pin *O* and one diametrically opposite at *S*. To properly locate these bushings the work is fastened on the central stud *I* and the hole for the index pin bushing *R* is finished first by drilling through one of the holes *P* in the work, which is then removed and the hole counterbored to admit the bushing *R*, as shown by the dotted lines. The hole in this bushing is lapped to exactly the same diameter as the six reamed holes *P* in the work. The index pin *O* is then made of tool steel, the head

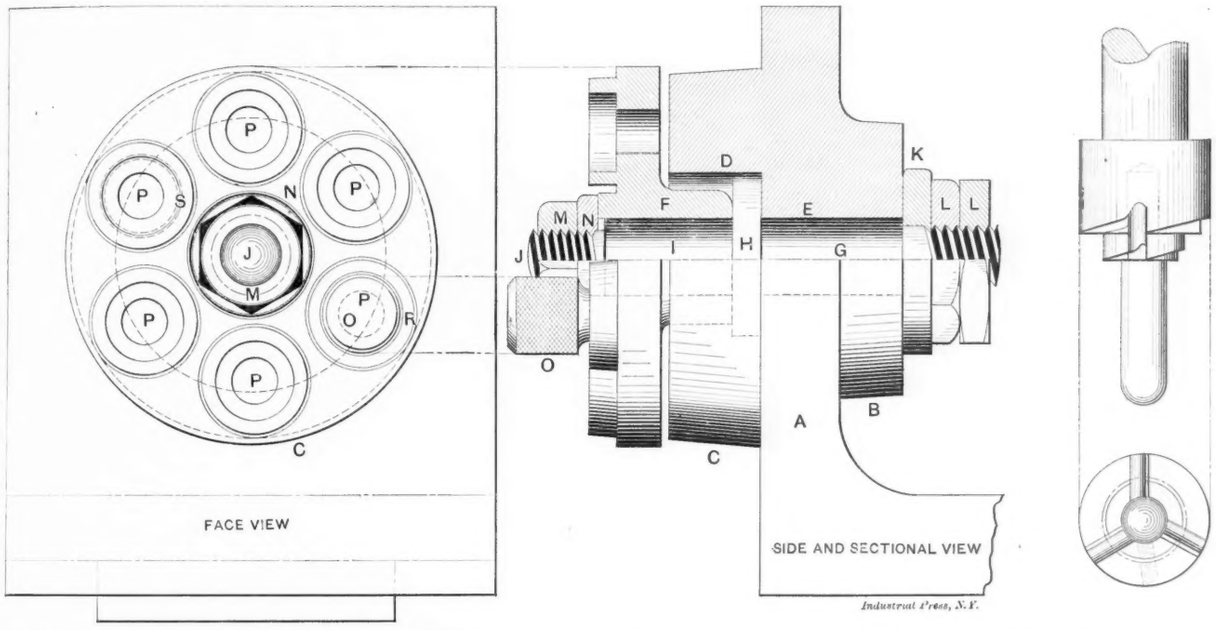


Fig. 10. Fixture for Milling and Counterboring the Bosses in the Piece shown in Fig. 5.

Fig. 11. Combination Counterboring and Facing Tool used with the Fixture in Fig. 10.

being knurled as shown, and is then hardened and ground to fit snugly within the reamed holes *P* in the work, and the bushing *R* in the fixture. The work is then refastened on the fixture, being located by entering index pin *O* through one of the holes *P*, and into the bushing *R;* and the hole for bushing *S* finished and the bushing entered in the same manner as the other.

To operate, the work is fastened on the fixture as shown, and the counterbore fastened in a taper sleeve in the miller spindle. The longitudinal and cross feed of the table are then manipulated until the lead or supporting stud of the counterbore is in line with, and can be entered into, the bushing *S*. The work is then fed against the cutter until the required amount of stock has been removed and the graduated dial on the cross feed screw set at *O*. The table is then moved back, index pin *O* removed, and the work revolved until the next hole *P* is in line with the bushing *R*. The index pin is then re-entered and the operation of counterboring and facing repeated, and so on until all six of the bosses have been machined.

* * *

The engines for the New York Rapid Transit subway power house are to be made by the Allis-Chalmers Co., and are to be of the combined horizontal and vertical type, like those for the Manhattan power house. They will be rated at 7,500 horse power each at the most economical point of cut-off, and will be capable of operating continuously under a load of 11,000 horse power each.

LYCOPODIUM POWDER IN THE FOUNDRY.

Lycopodium is a vegetable powder used by pyrotechnists and theatrical mechanics to produce a lightning-like flash effect sometimes needed in their business, and by druggists to sprinkle on pills, not otherwise coated, to prevent same from adhering to one another, and the purpose of this article is to advise founders to use it for the same reason that the druggist does, only in a slightly different manner and on very dissimilar material.

I refer to its use by a few founders here in the East to prevent the sand from clinging to patterns, both wood and metal, especially on molding machine work, and were it not that the founders referred to regard their knowledge of it as a dark secret to be jealously guarded from competitors, and are not broad enough in their views to exchange ideas with their fellow foundrymen, this article had better remain unwritten.

By the use of lycopodium, patterns that are considered nasty to draw are rendered, by a very light sprinkling from the dust bag containing this chemical, as easy to mold as the proverbial sashweight. It will be found invaluable as a means for drawing in loose pieces on big work, as practically no rapping is necessary, the piece fairly jumping out as a result of the least jar. For getting the best finish on names and numbers that are made of the usual lead pattern letters and figures and fastened on so that they only touch the pattern in spots, leaving open joints underneath for the sand to stick in and thus mar what would otherwise be a fine job, lycopodium is as the Balm of Gilead to the heartsick founder who is tired of having castings sent back because an A was made to look more like a Z by these very conditions.

On large work it is sometimes used when there is a deep draw with little if any draft, and to make it stick on the vertical sides or faces some founders spray gasoline or naphtha on the pattern. Before evaporation on the one hand and capillary attraction on the other claim the oil as their own. "lyco" is sprinkled on so that it "cakes," and by this method you can riddle or shovel sand into the mold without fear of displacing the dust that has a specific gravity of only .5.

Send the "cub" to the nearest drug store for a nickel's worth and put it in a bag made of goods not too loosely woven and give it a "try," at least, on your molding machine patterns, and I think you'll like it; and you needn't be afraid of an explosion or rumpus of any kind, when the hot metal strikes it, due to its pill-separating and lightning-producing qualities, even in conjunction with gasoline or naphtha, as there is absolutely no danger.—*Patternmaker in the Foundry.*

COPYRIGHT, 1901, BY THE INDUSTRIAL PRESS.

Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY

A Practical Journal for the Machine Shop.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

9-15 MURRAY STREET, NEW YORK CITY.

CHICAGO—1505 MANHATTAN BLDG. BOSTON—620 ATLANTIC AVE.
PHILADELPHIA—MACHINERY FLOOR, THE BOURSE.

DOMESTIC SUBSCRIPTIONS, $1.00 A YEAR. FOREIGN $1.50 A YEAR.
SINGLE COPIES TEN CENTS.

LESTER G. FRENCH, Editor. FRED E. ROGERS, Associate Editor.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Domestic trade is supplied by the American News Company or its branches.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

DECEMBER, 1901.

CIRCULATION STATEMENT.

MACHINERY reaches all classes—journeymen, foremen, draftsmen, superintendents and employers; and has the largest paid circulation in its field in the world. Advertisers will be afforded every facility to verify the statement of circulation given below.

1901.		1901.		1901.		1901.	
Jan.....	27,500	April....	26,000	July.....	28,964	Oct.....	28,345
Feb.....	26,500	May.....	26,500	Aug.....	29,492	Nov.....	31,743
Mar.....	30,000	June.....	28,000	Sept.....	28,165	Dec.....	29,237

No other paper in this field prints its circulation figures.

It is a matter of common knowledge among machinists that a large surface plate is likely to become inaccurate after much use, more because of the pening action of the work applied to the surface than by the wear. This is especially true of surface plates used in blacksmith shops for straightening bars. Such plates will soon become high in the center because the upper surfaces have been pened by the repeated blows into a state of compression which warps the sides of the plate downward. The same condition is sometimes met on planer platens. That planing off a platen pened out of truth by any cause will again put it in good condition depends somewhat on the amount it is out. If it is found "humped up" 3/8 inch in the center and is planed off without an attempt being made to modify the "hump," as in one case known, the result in all probability would not be a very satisfactory one. The best practice in such cases, as in most others, is prevention. By deeply scoring the surface of platens with lines two inches apart, both laterally and longitudinally, cut by a sharp narrow tool which will sink in quite deeply without cutting a wide track, the trouble will be overcome, without in any way harming them. Then the occasional planing off of the surface will merely remove the local inaccuracies and nothing more than a "skin" cut will be necessary.

* * *

A PIECEWORK-PREMIUM SYSTEM.

In starting a piecework system it is generally determined from the cost cards how much a man has been producing when working at a day's pay and when he is placed under the new system he is told that thereafter he will be paid so much per piece and will be paid by the piece only. The price is set at a figure that compels the man to work faster to earn even as much as he did before, and he well knows that if he works very much harder and increases his wages very largely the price will again be cut; and so for his own protection and the protection of those who may follow him on the same work he is careful to keep his wages within the "safe" limit. Under these conditions the man feels that there is no certainty for the future and becomes suspicious of those above him.

In isolated cases we hear of the premium plan of payment being used in lieu of the piecework system, and it is generally considered to be more fair and liberal toward the employee and by some more profitable for the employer. It is substantially a direct proposition made by the employer to his employed and the latter are in a measure free to accept it or not; although one who habitually refuses may find himself in disfavor and perhaps out of employment. In applying the premium plan a foreman approaches his men and in effect says: "Our time record shows that it takes you an hour, on an average, to complete one of the pieces you are to work upon. If you will work harder or devise some improvement to enable you to make more pieces per day, we will pay you half your hourly rate for every hour you save over the present time of sixty minutes for each piece. If instead of completing a piece in sixty minutes you succeed in finishing one every forty-five minutes you will receive, in addition to your day's pay, half rate for the two and one-half hours that you will save in a ten-hour day, making about thirty cents added to your previous wages of $2.50. You will, in any case, continue your regular pay of $2.50 per day whether you take advantage of our offer or not, as long as you stay in our employ, and no matter how much you may succeed in earning, your wages and rate of increase agreed to under this proposition will not be reduced."

It does not appear to us, however, that the difference between the piecework system and the premium plan lies so much in the system itself as in the disposition or the intention that is behind it. There is really no fundamental difference in principle between paying a man so much per piece for every piece of work that he finishes and paying him so much for every hour saved. In either case it is expected that the rate will be so fixed that the manufacturer will increase his profits through the introduction of the system.

The great evil of the piecework system is the disposition on the part of the manufacturer to cut the rate occasionally. Where the disposition to do this exists, however, it is just as easy to arrange it so that a workman cannot earn more than a stipulated amount under the premium plan as under the piecework system. It is simply necessary to devise new jigs or methods for doing the work and then to adopt new rates of payment, with the new methods as an excuse. This, in fact, is sometimes done when the manager thinks a workman is accumulating more wealth than is good for him.

When the premium plan is adopted it is with an evident disposition toward fairness, and this counts more than any mere details of system. The fact is recognized that it is better to guarantee a man his day rate, regardless of his production—discharging him if he does not do his duty—than to require him to receive a smaller amount when his production falls off. It is admitted that it is better to fix a rate equitable to both sides and to agree to adhere to it rather than to place the man in fear of a reduction in the rate and so cause him to curtail the production to ward off the threatened cut in rates. These are the features of the premium plan that distinguish it among other systems.

But are these features such that they could not be applied equally well to the piecework system? It is probable that no concern would be willing to pay wages under any system that were considered exorbitant for the services rendered and no reasonable workman would expect to receive exorbitant compensation. Suppose it was recognized at the outset that such was the case, and that with this understanding specific agreements were made with the employees to pay them certain piecework rates which were to hold for certain lengths of time, as a year, with the understanding that at the end of that time there should be a new agreement. The period should be long enough so that if the workman was able to introduce any new device to cheapen the cost of production, he could derive ample compensation for his invention in the way of increased wages before his agreement ran out.

Suppose it were also agreed that a man should receive his day rate regardless of the amount of production, as in the premium plan, making his acceptance of the terms to a certain extent optional.

Under such conditions as these it seems to us there would be no false pretences, nobody would expect more than he should receive, and every workman would be protected for a long period to make it an object to do his best, to become dexterous and to use his inventive faculties as well. Such a transaction would, at least, be business-like, and the piecework system thus managed would in effect be a piecework-premium system.

ANNOUNCEMENT.

Mr. Clarence P. Day has resigned the Vice-Presidency of THE INDUSTRIAL PRESS and retires from his connection with its publications on December 12th, for the purpose of engaging in a unique profession—that of Advertising Counselor. Mr. Day's new departure should not be classed with advertising agencies or brokers, as it is entirely separate and distinct, and he purposes giving different service from what is offered by any agency. In this position, his eighteen years' experience in their field will enable him to offer mechanical advertisers who are seeking the most effective results from their advertising, services which should be of great value to them in securing the most effective results from their outlay.

Mr. Day's preliminary announcement appears in another column of this paper, and we feel sure his many friends will join with us in wishing him unqualified success in his new undertaking.

* * *

NOTES AND COMMENT.

Our attention has been called by Mr. Arthur to two errors which appeared in his article on the Remontoir Clock, published in the November number. On page 72, left-hand column, the ninth line from the bottom should read: "downwards, because brass has less than *twice* the rate of steel." On page 73, left-hand column, the thirtieth line from the top should read: "regular depth. Mesh these gears *fifteen-sixteenths* the usual depth."

Ezra Gould, the founder of the firm of Gould & Eberhardt, Newark, N. J., died in that city on November 2, aged ninety-three years. Mr. Gould retired from business about ten years ago, but it is said that he occasionally paid visits to the works. He learned the machinist's trade at the Rogers Locomotive Works, Paterson, but later he moved to Newark and engaged in the machine tool business, which has been the work of the shop ever since. Mr. Gould was one of the first to build milling machines and gear cutters in this country.

From May to September, 1902, there is to be an exhibition at the Crystal Palace, London, England, of exclusively American products, arts, industries and inventions. This, it is stated, will be the largest and most important of its kind ever seen in the United Kingdom. As the year 1902 will be marked by the coronation of King Edward VII, no more auspicious time and place could have been selected for an exhibition, as the historical event to take place in London will draw to that city a great number of visitors. A commercial bureau will be established under the direction of a committee of representative American and British firms, where information will be supplied regarding channels of trade, and the placing of goods upon the British and Continental markets, Any particulars regarding the exhibition can be had by applying to Alfred H. Post & Co., Produce Exchange, New York.

CONVEYING ENERGY FROM THE COAL MINE.

There is a great deal of talk of doing away with the present expensive and wasteful method of mining coal and transporting it to market by railways. The electricians are predicting that it will be done away with in time and that huge power stations will be located in the near vicinity of the mines and electric energy transmitted to great cities by high-tension currents. While this seems an ideal condition now, it is certainly not impossible and will undoubtedly be found less expensive for power than the present system. The great difficulty, however, is that a large part of the coal annually burned, is for heating purposes. The use of electricity for heating is hopeless with any present known apparatus for transforming the energy of coal into electrical energy. The losses by electrical heating are enormous, the efficiency being less than ten per cent. This being the case, it would appear that the best practical method of getting coal, or rather its product, to market will be by pipe lines, and in the form of gas. While gas which has been under heavy pressure is not well adapted to lighting in ordinary gas burners, it is an ideal fuel and can be utilized for power in gas engines with fully as economical results in many cases as electricity and electric motors. The cost of pipe lines would be heavy, but the cost of operation is very low.

John A. Johnson, late president of the Gisholt Machine Co., Madison, Wis., died at his home in Madison on November 10. Mr. Johnson was a native of Norway. His parents came to America when young Johnson was but 12 years old, and as a boy he worked on a farm and later sold farm machinery, and in 1862 he started in the implement business with Mr. M. E. Fuller, under the firm name of Fuller & Johnson. It is said that the large line of implements manufactured by the firm was for the most part the product of his inventive genius. Many of his inventions have been patented. About ten years ago Mr. Johnson organized the Gisholt Machine Co. for the manufacture of lathes, in which they have been very successful, the Gisholt lathe being well known. His four sons, all of whom were machinists, were associated with their father in his new enterprise. For some time past the management of the Gisholt plant has been entirely in the hands of the sons of Mr. Johnson, owing to the father's poor health, and there will be no break in the Gisholt plant by reason of Mr. Johnson's death. The Gisholt Company received its name from the city of Gisholt in Norway, the birthplace of Mr. Johnson.

DE LAVAL TURBINE.

The steam turbine as a prime mover for general purposes promises to soon become a formidable rival to the reciprocating steam engine. The Parsons steam turbine is being built in the United States by the Westinghouse Machine Company, East Pittsburg, Pa., and the De Laval Steam Turbine Company are preparing to build the De Laval steam turbine on an extensive scale. They have built new machine shops at Trenton, N. J., which will be equipped with the best modern machine tools and appliances for economical manufacturing. The main shop building is of saw-tooth side and center nave construction which is unsurpassed for light. It will be equipped with electric traveling cranes and the machine tools will be electrically driven. Some of the machine tools are very costly, being of special design, especially the spiral gear cutting machines built for the company by the Pratt & Whitney Co. Spiral reducing gears are used in the De Laval turbine for reducing the rotative speed of the driving shaft, as the speed of the turbine wheel is too great to allow it to be directly connected for almost any purpose except that of driving centrifugal separators. Hence the desirability of gear cutting machines of the highest attainable perfection of product to produce noiseless gears.

A. S. M. E. MEETING.

The forty-fourth meeting of the American Society of Mechanical Engineers will take place from Dec. 3 to 6 in the society's headquarters, No. 12 West 31st Street, New York. The following are the subjects that will be discussed at the various sessions:

Opening Session, Tuesday evening, 3rd: Annual address by President Samuel T. Wellman, the title of which will be "Early History of Open-hearth Steel Manufacture in the United States."

Second Session, Wednesday morning—"Cost of Running Trains at High Speed." "Some Peculiarities of Springs." "The Linvolpon System of Units."

Thursday morning—"A portable Accelerometer for Railway Testing," by F. B. Corey. "A Bonus System of Rewarding Labor, by H. L. Gantt. "A Silent Chain Gear," by J. O. Nixon. "The Bursting of Small Cast-iron Flywheels," by C. H. Benjamin.

Third Session, Thursday evening—"A New Valve Gear for Gas, Steam and Air Engines," by E. W. Naylor. "The Potter Mesh Separator," by F. A. Scheffler.

Closing Session, Friday morning—"Working Loads for Manila Ropes," by C. W. Hunt. "The Heat Engine Problem," by C. H. Lucke. "Experiments on Spiral Springs," by C. H. Benjamin and R. A. French. "Water Power Development at Hannawa Falls," by W. C. Johnson." "The Porro Prism," by W. R. Warner. "Effect of Clearance on the Economy of a Small Engine," by Albert Kingsbury.

FELLOWS RACK SHAPER.

The Fellows Gear Shaper Co., Springfield, Vt., are now manufacturing a rack shaper which operates on the same principle as their gear shaper, although the mechanical movements of the machine have been worked out on somewhat different lines, owing to the different requirements of the case.

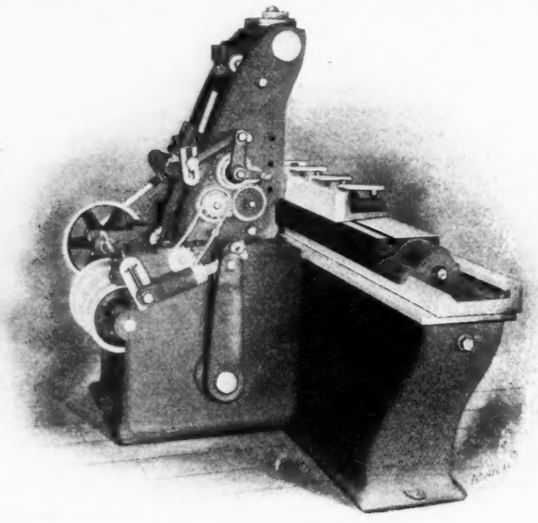


Fig. 1. End View of Shaper.

A rack cutter on this principle has been in operation at Springfield, Vt., for some time, thus giving ample opportunity to perfect the machine and to thoroughly test it before placing it on the market.

The Fellows gear shaper is familiar to most of our readers, but a brief explanation of the principle of its operation will not be out of place and will be of assistance in the explanation of the rack shaper. In the former machine the cutting tool is an accurately formed gear wheel of tool steel, with the teeth properly backed off. The cutter is carried by a cutter bar, which moves in a vertical direction and is supported by a carriage, which travels in a horizontal direction on a cross rail. The gear blank is supported on a vertical arbor and the cutter is fed into it to the depth of the tooth, this distance being determined automatically; and then the cutter and blank revolve at the correct relative speed, and the teeth are thus formed upon the well-known principle that a gear tooth can be made to shape its conjugate in a blank running in correct relations to it. But one cutter is required for any wheel of a given pitch within the machine's capacity. As this is ground accurately after it is hardened, the work cut by it is of necessity accurate and should run correctly with any other gear made by the machine, even though the diameter of the blank is not exactly correct.

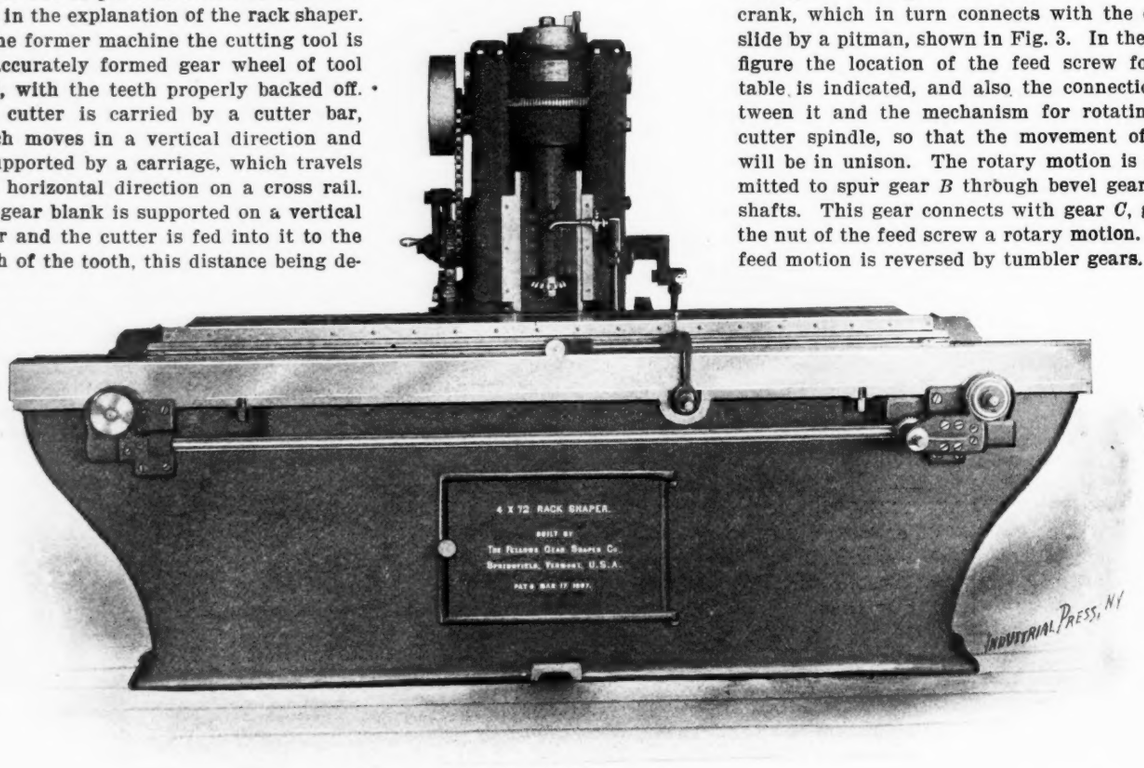


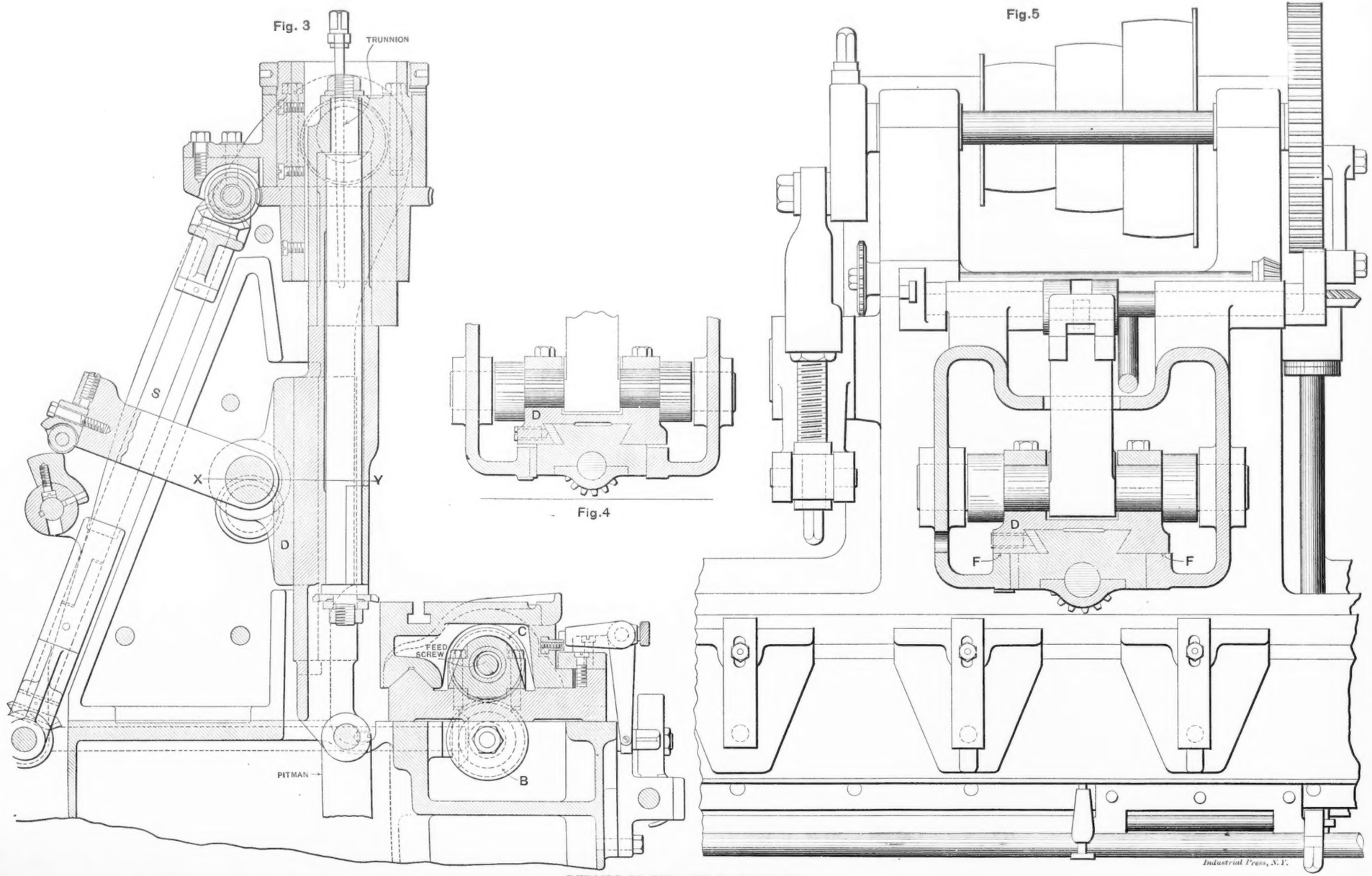
Fig. 2. Front View of Shaper.

The rack shaper operates upon the same principle as the gear shaper, using the same cutter. For the rotary motion of the gear blank is substituted the straight-line motion of the rack blank. During the return stroke of the cutter it is, of course, necessary that the blank and the cutter should be separated slightly to prevent the destruction of the cutter by wear. In the gear shaper this is accomplished by a slight movement of the blank, but in the rack shaper the cutter and cutter slide are the parts that are moved. It will be seen from the engravings that the cutter slide is suspended upon trunnions, which allow the entire slide to have a limited swinging motion. The lower end of this slide bears in an auxiliary guide marked *D* in each of the three views on the opposite page, and the position of which guide is controlled by a cam-actuated lever. The faces *F* of this auxiliary guide, seen in the plan in Fig. 5, are held rigidly against an inner face of the main frame, during the downward or cutting stroke of the cutter slide. The auxiliary guide, together with the main frame, thus forms an ordinary slide bearing for the cutter slide. During the return stroke of the cutter the auxiliary guide carrying the cutter slide is withdrawn from the blank an amount sufficient to prevent the rubbing of the cutter.

The rotary motion is transmitted to the cutter slide through an inclined shaft *S*, Fig. 3, which operates a worm and wormwheel at the upper end of the spindle through bevel gears. The connection between the spindle and the wormwheel is through a semi-circular slide so designed as to prevent lost motion at this point, this slide being the same as used in the more recent designs of the gear shaper.

The reciprocating motion of the cutter slide is obtained through a driving crank which actuates a bell crank, which in turn connects with the cutter slide by a pitman, shown in Fig. 3. In the same figure the location of the feed screw for the table is indicated, and also the connection between it and the mechanism for rotating the cutter spindle, so that the movement of both will be in unison. The rotary motion is transmitted to spur gear *B* through bevel gears and shafts. This gear connects with gear *C*, giving the nut of the feed screw a rotary motion. This feed motion is reversed by tumbler gears.

It is recommended that in using the machine the feed be reversed after cutting a set of blanks, and the next set cut by running the platen in the opposite direction. This saves returning the platen to the starting point at each operation. Mechanism is provided by which the feed can be tripped at any position of the platen in either direction. A power quick



DETAILS OF FELLOWS RACK SHAPER.

Fig. 3. Section on Cutter Spindle Center. Fig. 4. Section on X Y, Fig. 3, showing Cutter and Cutter Slide moved back to clear Rack on Return Stroke. Fig. 5. Plan, with Section on X Y, Fig. 3,

return of the platen in either direction is also provided. Depth adjustment is controlled by the two short screws seen in the plan. These screws are operated by hand in unison by the rod extending across the front of the machine. A graduated dial indicates the depth in thousandths.

The blanks are held by a system of clamps which are removable, permitting any form of blank to be operated upon, as in cutting a rack upon a heavy slide. These clamps are seen in the end view and plan, but have been removed in the front view. An oil pump and the necessary pans are also provided.

One peculiarity of this machine is that no change gears are required. As the cutters all have the same pitch diameter, they all roll in unison with the blank. The capacity of the machine is from 16 to 5 diametral pitch inclusive, and is built in lengths of 5, 6, 8, 10, and 12 feet.

* * *

THE ANNUAL AUTOMOBILE EXHIBIT.

AT MADISON SQUARE GARDEN, NEW YORK.

The second annual exhibit of automobiles, automobile parts and accessories under the auspices of the Automobile Club of America, was held at the Madison Square Garden in New York from November 2 to 9. It was a successful show both as a demonstration of the development and improved construction of the automobile and in the number of machines sold. The sales were estimated to be nearly $2,000,000, which if one-half true shows the present importance of the industry and is fair indication of what will be its importance in the near future.

Nearly 150 machines were exhibited on the main floor of the Garden by the various manufacturers and in the restaurant room attached were shown about 25 machines loaned for the occasion by the club under whose auspices the exhibit was held. The type of automobile most in evidence was that driven by internal combustion motors. Next in importance were the steam driving machines and the electric machines were naturally in the minority because of their limitation to localities furnishing electric energy. Practically all of the racing machines shown were of the gas engine type, and almost all follow the style of the French machines, the variation from pure imitation being more in the matter of detail than in general design. These formidable road locomotives have multi-cylinder engines, four cylinders being not uncommon and some having six cylinders, as in the case of the Winton racing machine, which has a six-cylinder gas engine of 40 H. P. The famous Fournier machine, which has a six-cylinder engine of 60 H. P., was also shown on the main floor. This machine has made road records of nearly one mile per minute. The complication of machinery because of so many cylinders is preferred to the excessive vibration which appears inseparable from machines having one- or two-cylinder engines.

While the attention bestowed on the racing automobile may result in developing the ordinary types, it is in general to be deplored since the future of the industry is not in building racers or pleasure machines so much as it is in the automobile for more utilitarian purposes. At present, however, there is no doubt that the first two types are the most profitable, since scarcely enough has been done in the development of the motor-truck to merit serious attention. But the future of the automobile is, in the opinion of most conservative observers, that of a burden-carrier as it will in this capacity serve the best and greatest interests. The displacement of the horse from city streets and the facilitating of freight moving by its general use, would transform dangerous and nerve-racking highways of confused traffic in great cities into boulevards of commerce on which freight as well as pleasure vehicles move noiselessly and swiftly.

The manufacture of steam-driven machines seems to be along more conservative lines, and the machines are more purely of American design. Because of its simplicity and reliability, the steam automobile is as much of a general favorite as it is because of lower price. It is not so noisy as the gas-engine machine, and is freer from vibration, two quite essential requirements for a pleasure vehicle. A great deal of criticism has been made of the automobile because of its being a copy of the horse-drawn vehicle with the horse left off. The steam machine exhibit showed a general tendency to depart from this alleged defect, although it was quite noticeable in some individual cases.

Without question the electric machines shown were most trim in appearance and the smoothest and quietest running. The present state of the storage battery, however, while giving promise of greatly extending the radius of action of the electric vehicle, is not such as to warrant the use of electric machines except for city use, keeping always within a safe distance of the base of supplies.

The exhibit of automobile parts and accessories was fully as interesting as the complete machines, if not more so to many visitors. Among the new things in the gearing line was the Brown-Lipe equalizing gear, which does with spur internal and external gears what the ordinary form does with bevel gears. The advantages claimed for this device are that it is cheaper, wears longer, and wastes less power by friction.

Noiseless gearing is naturally very desirable for automobiles, and for this reason the exhibit of the New Process Rawhide Co. attracted attention. A practical demonstration of the difference in the noise produced by two metal gears running together, and one metal and one rawhide gear, was made by a model consisting of a large gear driven by an electric motor through two pinions mounted on the same shaft. One of the pinions was of cast iron and the other of rawhide. With the former in mesh with the large gear, the noise was considerable, although the gears were machine cut, while with the rawhide pinion in mesh the noise was imperceptible.

An automobile is as dependent on good tires for success as a bicycle and is of course much harder on them because of its far greater weight. The development of pneumatic tires for automobiles, capable of supporting 800 to 1,000 pounds each and still be resilient and almost puncture-proof, is one of the remarkable features of the industry. It would naturally be thought that a three-inch tire with walls one inch thick, leaving a space for air only one inch in diameter, would be harsh and unyielding, but such tires were shown which were remarkably elastic. Bicycle tires of similar construction are made by the same company, having one-half inch walls and a one-half inch air space. Such tires are practically punctureless, and while not as resilient as thinner wall tires, they are so reliable as to specially commend themselves to users requiring a most reliable tire. The price is high, being about $7 apiece.

The exhibits of seamless tubing and seamless boiler shells were specially interesting as were also the automobile steam boilers. They were mostly of the fire-tube type, the shells being seamless and the tubes copper or of steel coppered over to prevent corrosion. The tubes, usually about one-half inch in diameter, are crowded as closely together as possible, so that in a boiler 16 inches in diameter as many as 350 tubes may be found. Such a steam boiler designed to carry a steam pressure of perhaps 200 pounds per square inch and to develop six or eight horse power in a space of, say, two cubic feet, is a feat of engineering.

Among other features of the show, the abandonment of the steel wire spoke wheel and the general use of the wooden wheel was at once apparent. While the steel wire spoke wheel was specially adapted to the bicycle, it has been demonstrated not to be so for the automobile, because of side stress which, of course, is not borne by the bicycle wheel.

* * *

Electricians will be greatly edified by the following scientific explanation of "why our feet get cold" as perpetrated in the advertisement of an "electric" insole. "In the first place, the human body is an electric battery, the upper half being positive and the lower part negative. The earth on which we stand is a powerful magnet. In damp or cold weather the moist or cold earth attracts the electricity from the body, which is taken up by the magnetic globe on which we stand, thus depleting our bodies by extracting from them the electric forces or currents which keep the blood in motion. Thus it is that our feet become cold for want of circulation. If we run, jump or dance, the molecules of blood by stimulation and attrition, vibrate among themselves, such vibration being the source of electro magnetic heat, whether in the foot or in the brain," etc.

NOTES FROM THE METROPOLITAN STREET RAILWAY POWER STATION.

The installation of the eleven engines and generators at the new Metropolitan Street Railway power station at Ninety-fifth Street and East River, is slowly nearing completion. There are now in running order eight of the Allis 5,000 horse power vertical compound condensing engines driving General Electric alternating generators of 3,500 kilowatts each. Two more engines and generators are in process of erection, and the third will follow directly as they are being finished.

The eight completed engines have simultaneously carried a load of nearly 38,000 horse power without trouble. Aside from the hum of the alternators, due to the molecular vibrations in the armature and field coils, there is scarcely any perceptible noise from the operation of the huge engines and generators, while each unit is developing and transforming into electrical energy nearly 5,000 horse power.

The erection of the engines is an interesting process on account of the magnitude of the work. The hollow steel shafts alone weigh about 74,000 pounds, and the flywheels over 300,000 pounds each. To this enormous weight borne by the bearings must be added that of the revolving fields, connecting rods, crossheads and pistons. Although the shaft is 37 inches in diameter and made of fluid compressed steel, it is perceptibly deflected by the enormous weight carried. So perceptible is the deflection, that the erectors throw the vertical axis of the cylinders out of plumb about one-eighth inch in the height of the engines. By doing this the connecting rod brasses are made to bear squarely on the pins, which, of course, would not be the case if the engines were set exactly plumb under the conditions named. That these shafts are able to bear such loads for an indefinitely long period of service during which time they are perceptibly bent back and forth millions of times, is a striking testimonial to their integrity and spring-like qualities.

During the erection of the engines, a new feature of piston construction has been adopted, and all the pistons have been fitted in the same manner. Each of the pistons has one packing ring, set out by springs. The high-pressure rings are made in two parts, the joints being fitted with brass keepers to prevent leakage. The feature of construction referred to, Fig. 1, is that the bull-ring is made integral with the follower plate instead of the two being separate as usual. The bull-ring and follower thus form an inverted cup casting 46 inches in diameter, with a large hole in the top. The bull-ring and follower are held to the steel piston by twelve large screws, whose heads are set flush with the surface of the follower face. Screw holes for eye-bolts are provided for removing the combined follower and bull-ring from the cylinder. To examine the packing the twelve bolts are removed and the bull-ring removed without disturbing

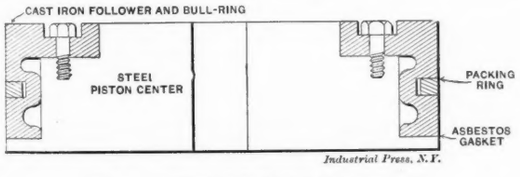


Fig. 1. Combined Follower and Bull-ring.

the piston. The bull-ring abuts against a flange on the piston, an asbestos gasket being interposed to prevent leakage. The advantages of this construction are that there is no chance for the bull-ring to work loose between the piston and the follower plate, and that it makes a more simple construction which is as convenient, or more so, for examination than the ordinary form.

On the low-pressure pistons, which are 86 inches in diameter, the construction is somewhat different. The follower and bull-ring are made in one piece and held in the same manner. The packing ring, however, is placed near the top instead of in the center of the bull-ring, and a narrow ring follower holds it in position. The follower ring acts as a bolt-lock to the follower bolts, being set so close to them that the heads must all be turned with a flat next the ring. With this construction, the packing ring may be examined without removing the bull-ring, by taking off the narrow follower ring referred to. This construction is undoubtedly stronger than a solid cast iron piston would be, and it avoids the bad-wearing qualities of an all-steel piston.

To easily get the high-pressure cylinder bull-ring into the cylinder with the packing in place, Mr. Tomlinson, the assistant chief engineer, has a useful kink. A thin steel band made in two parts is placed around the bull-ring so as to cover about one-half the upper width of the packing ring. The band is drawn together snugly on the packing by nuts on the screws holding the two parts of the band together. In this manner the packing is easily forced into the bull-ring so as to be flush with the surface. When being lowered into the piston, the band is removed as the packing enters the counterbore. The packing is thus started with none of the pushing and prying against the packing, which is both dangerous and trying when on top of a vertical engine cylinder at a distance of forty feet from the floor.

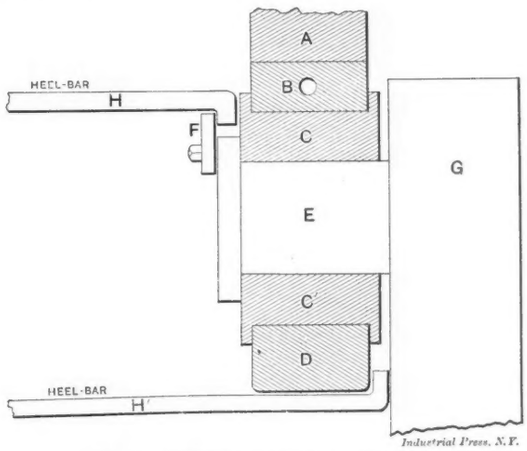


Fig. 2. Adjustment of Crank-pin Brasses.

The manner of adjusting crank-pin brasses of such large engines is not without interest, since obviously somewhat different means must be taken to do it nicely than on small engines with which most engineers are familiar. The ordinary process of screwing up the adjusting wedge and pushing the connecting-rod back and forth on the pin by hand to test the adjustment is scarcely practible when the weight on the pin, as in this case, is not far from fifteen tons. Yet essentially the same procedure is gone through by the aid of simple mechanical aids to move the rod sideways on the pin. Each pin is drilled and tapped in its face with two 1-inch holes. These holes are for screws for holding the piece *F* in Fig. 2 to the face of the pin when adjusting the brasses. The holes are ordinarily filled with two flush-head screws for the sake of a neat appearance. The piece *F* forms a fulcrum for a heel-bar *H* to force the connecting-rod inward on the pin. To throw it outward another heel-bar *H'*, is inserted between the strap *D* and the crank-disk *G*. The adjustment is made by screwing the wedge *B* between the end of the connecting-rod *A* and the brass *C* in the usual manner. Helpers on the end of the upper heel-bar *H* throw the connecting-rod inward, and the engineer attending to the adjustment throws it outward with the heel-bar *H'*. After reaching the limit of adjustment at which the rod can be comfortably moved back and forth by the heel-bars, the wedge is slacked back such an amount as the engineer's judgment decides will be sufficient for cool running.

To prevent the wedges rusting so as to move very stiffly, as they will often do, even when deluged in a bath of oil, four shallow oil grooves are cut across both faces bearing against the rod end and the brass. The oil grooves allow the oil to get to the faces and prevent them rusting to any great extent.

The adjustment of the brasses on the crank-pin and on the crosshead-pin, is made both for the high- and low-pressure sides with the crank-pin at the top center. The engine is turned over by hitching a chain around a spoke or the rim of the flywheel and engaging with it the hook of the 30-ton Sellers traveling crane, which serves the entire floor space. In this manner the engine is slowly turned over by power and stopped at any point wanted.

LETTERS UPON PRACTICAL SUBJECTS.

JIG FOR BORING CRANK-PIN HOLES.

Editor MACHINERY:

The accompanying cuts illustrate a jig designed for boring crank-pin holes in flywheels, as used on donkey pumps, straight-line air-compressors, etc., where there is a flywheel on each end of the shaft and a rod connects the crosshead with a pin in each flywheel. It is very important in cranks of this character that both pins have precisely the same throw and that there be no advance of one pin over the other, as otherwise there will be brought to bear upon the crosshead connections a bending effect which will cause trouble by binding, etc.

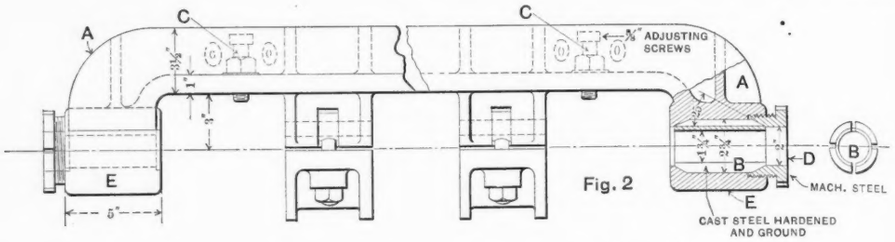


Fig. 2

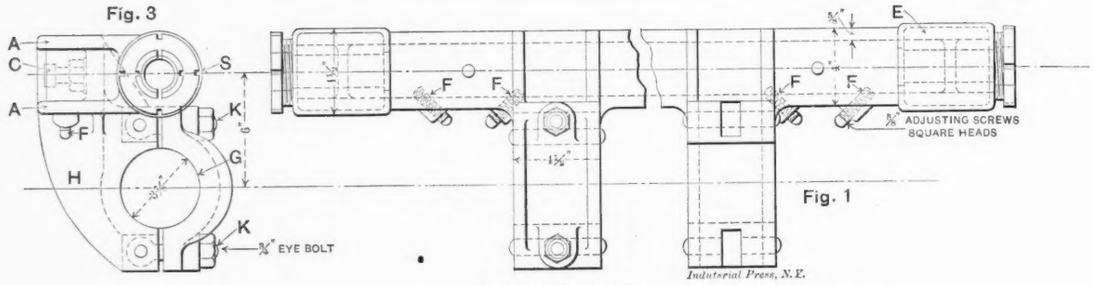


Fig. 3

Fig. 1

Details of Boring Jig.

Another commendable feature connected with the adjustable bushing is the facility with which it may be replaced by another of different size, thus allowing bars of various diameter to be used, with the advantage at the same time of close working fits between bars and bushings. This frequently becomes necessary in work of this character when the stock in the holes to be bored is too great or when the holes are out of line to such an extent as to prohibit the regular bar being used. Two or three sets of bushings can be made, with different sized holes, to suit the requirements.

The adjusting screws *C C*, Fig. 2, and *F F*, Fig. 1, are to be set out against the hubs of the cranks and the arms of the wheels, respectively, after the jig has been set in its proper position, which effectually prevents any twisting of the jig upon the shaft and obviates the necessity of putting any great strain upon bolts *K K*, Fig. 3.

In making the jigs for the various sizes one of the principal things that had to be kept in mind was that the maximum rigidity must be secured; at the same time, however, the weight should be no greater than necessity demanded on account of handling. But under no circumstances should too little metal be put into any jig in the endeavor to reduce the weight, even if the conditions demand it; for if that is done the probabilities are that sooner or later it will have to be added in the form of patches or perhaps of an entire new jig. Figs. 1, 2, and 3 show three views of the jig, which is, as drawn, intended for a machine with a stroke of 12 inches.

The webs of the frame *A* and *H* are made quite deep, and the bearings for the boring bar are made abundantly long, as they have much to do with the securing of a good hole. The usual solid bushing has been dispensed with as being unreliable and the one shown in section in Fig. 2 used in its stead. This construction is slightly more expensive to build than the solid bushing, but is so far superior to it that the increased cost need hardly be considered. The hub *E* is bored and reamed, and then the bushing *B* is turned up, after which four slots are milled in its outer surface lengthwise, as shown, one slot going all the way through the shell, while the remaining three go within about one-eighth inch of the bore. The bushing is then hardened and ground to slide into the hole in the hub *E* with about .002-inch clearance. A feather, not shown in the drawing, is fastened permanently in the hub to prevent the bushing from turning and is made to slide freely through either of its four slots, thus making it immaterial which way the bushing is placed in the hole and also allowing for preventing unequal wear. The nut *D* might have been made of cast steel if desired, but machining steel answers very well, however. Four slots were milled in its flange to receive a spanner for turning it, as shown at *S*, Fig. 3. When the boring bar is placed in position in the bushing the nut is turned in against the bushing until a slight friction is felt on the bar when turning it by hand. This, of course, does away with all play between the bar and the bearing, with its consequent chatter.

Fig. 4 shows the method of fastening the cutters in the boring bar. The pin *I* is made of cast steel turned to a taper of ½ inch to the foot and hardened. The front edge of the cutter is so placed that it will cover about one-half of the diameter of the pin hole, and the part of the cutter that covers the hole filed away almost entirely, leaving just sufficient stock for the pin to press against when it is driven in

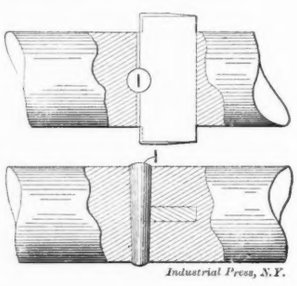


Fig. 4.

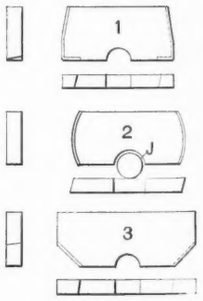


Fig. 5.

tight. The cutters are turned while in this position, then taken out, hardened, replaced and ground to size. A number can be made at one time and kept in stock, being first carefully marked.

Fig. 5 shows a set of cutters for boring a hole. No. 1 is the roughing cutter and is held in the bar in the manner shown in Fig. 4. Two rough cuts should be taken, and consequently two roughing cutters will be required for each hole, the second cutter leaving about .025 inch for the finishing cutter. The finishing cutter, No. 2, which is of the form shown with rounded cutting edges, can be left loose in the bar. It is placed in the same slot as cutter No. 1, but the semi-circular groove *J* in it is enlarged so that when the

cutter is in its proper place the pin does not come in contact with it, the pin being used in this case merely to prevent the cutter falling out of the bar previous to its entering the hole. Cutter No. 3 is used for countersinking the holes, which should be done before the finishing cut is taken. It is held in the bar in the same manner as cutter No. 1.

There are several methods of applying power for operating.

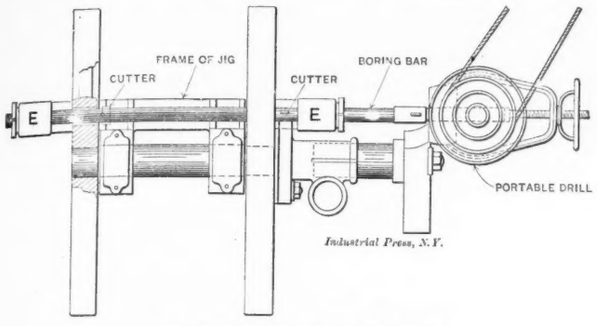


Fig. 6. Method of Driving the Bar.

A universal drill is a good driving mechanism in so far as power and feed are concerned, but as a rule drills of this character are kept busy on other work. A very good arrangement is that shown in Fig. 6. It consists of a rope-driven Dallett portable drill, attached to the boring bar direct. The method of attaching is already shown in the cut, the drill being bolted against the finished hub of the wheel in such a position that its spindle is brought in line with the boring bar. It does the work admirably and can be set in almost any out-of-the-way place when rope-driven. This is especially true if the drill be motor driven.

S. B. McQUADE.

Montreal, Canada.

* * *

SMALL INSIDE MICROMETER CALIPER.

Editor MACHINERY:

The accompanying sketch, Fig. 1, shows an inside micrometer caliper of my design which measures from 1 inch to 2½ inches, and has ¼-inch adjustment of screw. The external view, shown at *I*, Fig. 1, is full size, but the sectional view, Fig. 2, is enlarged to three times the actual size to better illustrate the details. *A* is the frame carrying the adjustable screw *O*, and *E* is the main screw which carries the barrel *B*.

Provision is made for the taking up of any wear that may occur in all necessary places. The wear of the nut and screw is taken up in the way commonly used in outside micrometers, that is, by turning the small nut *N*, Fig. 2, on the tapered end of the split bushing *O*. The contact piece *D* passes through the shell *B* and screws into the main screw *E*.

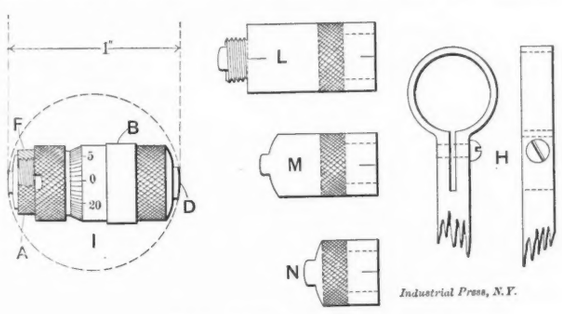


Fig. 1. Inside Micrometer.

holding them all together firmly, and there are two small flat spots on the head of this piece *D* so that a wrench can be applied to loosen it if it desired to rotate the barrel *B* on the screw *E* to bring reading line correct when adjusting for wear on contact piece *D*. As both contact pieces are hardened on their ends, wear is, of course, very slight.

The contact piece *C* screws into the frame *A* and is provided with a small taper headed screw *S*, which locks it firmly in position when screwed up, the end of *C* being split. The extension contact pieces *L*, *M* and *N*, Fig. 1, are all provided with this adjustment and screw onto the frame *A* up to a shoulder, there being a line on the extension piece and on the shoulder to show when it is up to its proper place. This line is shown on each of the extension pieces, *L*, *M* and *N*, in the drawing, and also on the small sketch of the micrometer at the left-hand end of its frame *A*.

The largest, or ¾-inch extension piece, is threaded on its outside end to the same size as the micrometer frame at *T*, allowing the ½-inch, or ¼-inch, extension pieces to be screwed onto it, thus making the capacity of micrometer 2½ inches. With this form of extension piece the operator does not need to use a magnifying glass, as is usually the case with other kinds, in setting rods to a line. The threaded portion of the frame at *T* can be covered with the small bushing *F*, shown in sketch, Fig. 1, when extension pieces are not being used.

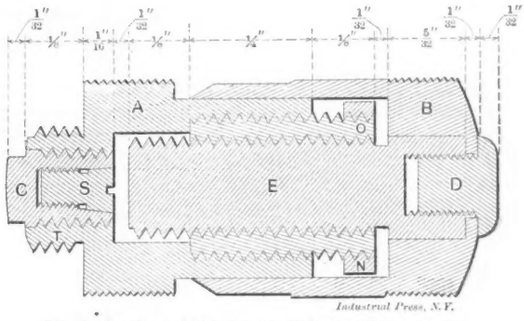


Fig. 2. Section of Micrometer Enlarged Three Times.

There is 1-32-inch clearance at both ends of the screw *E*, allowing the micrometer to close to 31-32 inch, and when out to its full extent there is ¼ inch of the screw in the nut *O*. The handle, shown at *H*, Fig. 1, is for use in deep holes, being clamped over the enlarged portion of the barrel *B* near its middle.

M. H. BALL.

Watervliet, N. Y.

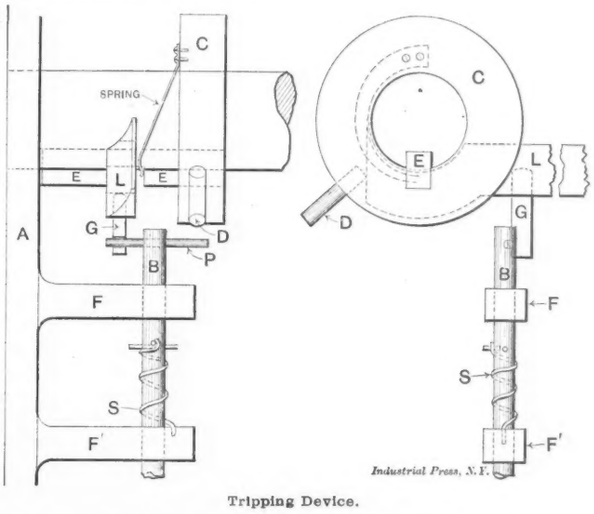
* * *

POWER PRESS TRIPPING MECHANISM.

Editor MACHINERY:

The accompanying sketch shows a tripping mechanism for a power press, the use of which makes it impossible for the gate to come down twice, even if the operator holds the treadle down.

A, in the cut, represents the side of the press, from which the two lugs *F F'* extend out. These lugs have the round pin *B* sliding through holes in them, and the spring *S* on the pin is so arranged as to hold it up and also to keep it turned around to the left so that the cross-pin *P* in its upper end is held against the latch-rod *G*.



Tripping Device.

When the pin *B* is pulled down by the treadle, the cross-pin which is hooked into the latch-rod *G* brings the main latch *L* down with it and allows the bolt *E* to slip along and engage in a clutch, causing the gate to come down. But as the collar revolves with the shaft, the pin *D* on the collar *C* comes around and strikes the cross-pin *P*, thereby throwing it out of the notch in the latch rod *G* and allowing the latch *L* to go back to the normal stop position.

When it is desired to operate again the treadle is raised by lifting the foot and the cross-pin *P* hooks into the latch-rod *G* again. In piercing the pin *D* is removed entirely, which prevents the constant tripping of the latch.

W. W. COWLES.

Waterbury, Conn.

* * *

FIXTURE FOR MILLING LAG-SCREW THREADS

Editor MACHINERY:

The accompanying cuts, Figs. 3, 4 and 5, represent a fixture used for milling lag-screw threads, as shown in Fig. 1, upon blanks as shown in Fig. 2, the finished pieces being for use on the spindles of jewelers' small polishing lathes to hold buffing wheels and scratch brushes. As it was not desired to center the blanks, and as there was considerable metal to remove, it was thought advisable to mill them rather than to cut them in the lathe.

The fixture consists of a spring chuck *C*, mounted on a slide *S*, which is capable of motion along ways on its base *B*. The slide is given its advancing motion along the ways by a leadscrew *L*, which is driven through the gear and pinion *G* and *P* from the shaft *A*, and at the same time the lead screw gives the chuck its rotary motion through the pinion and gear *p* and *g*, Fig. 3, *p* being feathered to the lead screw so as to be able to move along with the slide as it advances. The gear *g* is made as an integral part of the spindle which holds the spring chuck, the nut *N* on the end of this spindle being for the purpose of tightening or closing the chuck, as well as to hold the thin washer *W*, which keeps the pinion *p* in mesh with its gear while the slide is traversing. The axis of the spindle is, as shown in Fig. 3, inclined at an angle of 4½ degrees to the horizontal to allow for the taper of the screw. The long ⅝-inch shaft was driven from the feed of the milling machine through a universal joint fastened to it at the end *A*, and the required rate of feed of the blank per revolution of the cutter was properly determined by the ratio of the gears *P* and *G*.

In order to take a sufficiently deep cut to finish the screws at one cut, it was found necessary to support the blank by a suitably shaped steady-rest placed under it to bear the thrust of the cut, but it was found that a stop was unnecessary, because as soon as the slide reached the end of its traverse the resistance of feeding further would cause the feed belt to begin to slip, thus making it impossible for the cut to be carried too far. When the cut had been finished the machine was stopped and the table lowered, and the screw removed from the chuck. Then the pinion *P* was dropped out of mesh with the gear and the slide returned, rotating the leadscrew by hand, to its original position ready for another blank. The cutter was made especially for this work, the required shape of thread being obtained by a little experimenting. The fixture was, of course, fastened on the table with the leadscrew nearly in line with the spindle of the milling machine, being set out of line with it only to an angle equal to the obliquity of the threads of a 4-pitch screw, so as to provide clearance for the cutter.

H. J. BACHMANN.

New York City.

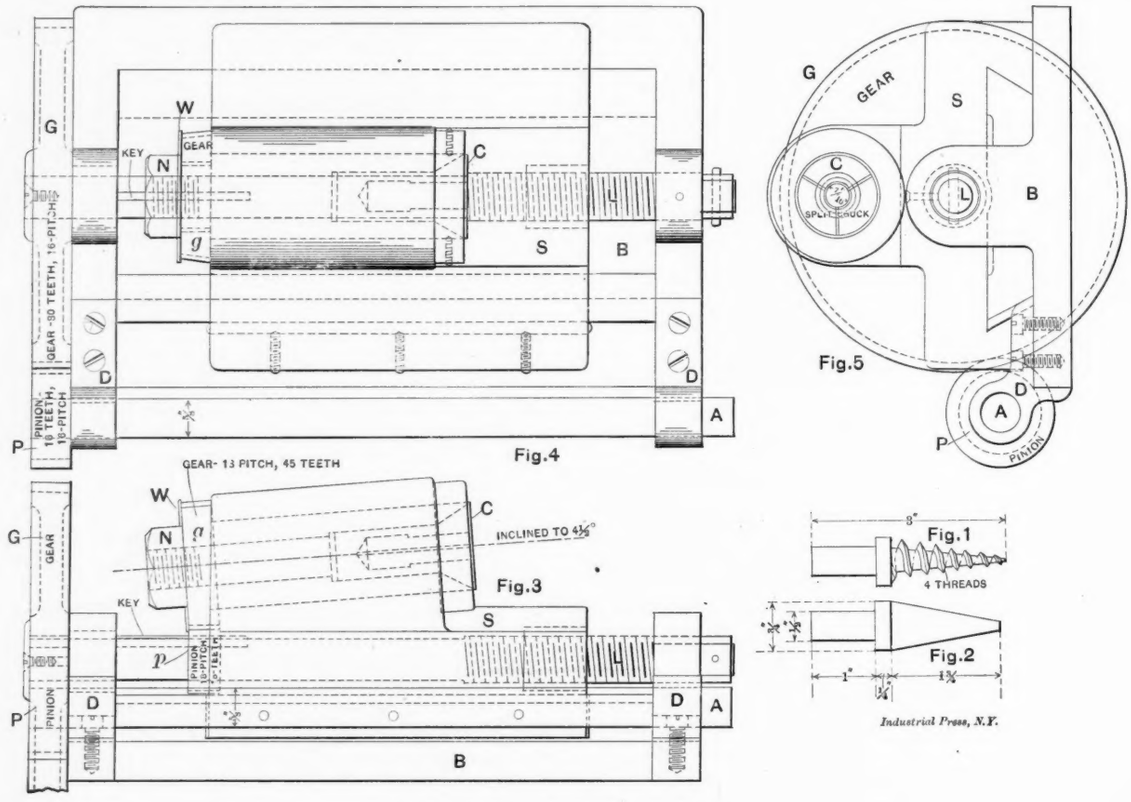
* * *

THE PLATFORM SCALE AS A COMPUTER.

Editor MACHINERY:

I do not pretend to say that the following is either new or original, but I give it, knowing that many of the readers of MACHINERY will be placed in the same position at the end of the year that I will, that is, of taking the annual inventory of the stock room and much of the stock will have to be accounted for as so many pieces. Now if you have an ordinary 600-pound platform scale, you will find that the 100-pound weight actually weighs only 1 pound, which thus makes the ratio between the weights on the platform and beam 100 to 1 for a balance. Now if it is desired to count 1,000 pieces of any stock article, which pieces are all of the same weight, place ten of them on the weight-hanger of the scale beam and enough more on the platform to just balance the beam, when it will be found that there are just 1,000 pieces on the platform. This scheme will work equally as well on any scale where the ratio between the beam and the platform is known; as, for instance, if the 100-pound weight of a scale is found to weigh ½ pound, one piece of any stock article on the beam will require 200 pieces of the same weight on the platform for balancing, because the ratio between the beam and platform is 200 to 1.

Detroit, Mich. W. F. T.



Details of Fixture for Milling Lag Screws.

LAYING OUT CAST-IRON ELLS.

Editor MACHINERY:

I wish to submit to readers of MACHINERY a simple and accurate method of laying out cast-iron ells, which is a method that I have used when limited to the use of a surface gage and trammels.

The accompanying cuts show the method as applied to an ell of the dimensions shown in Fig. 3. The ell is first set on the table in the position shown in Fig. 1 and the two lines

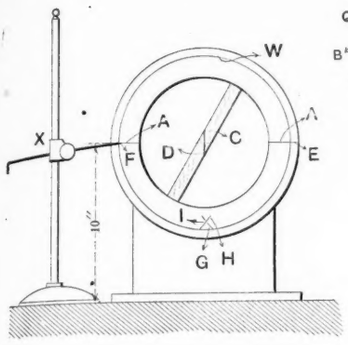


Fig. 1.

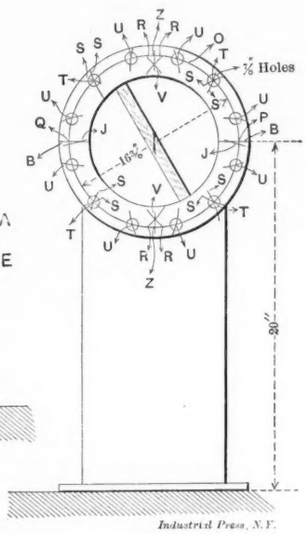
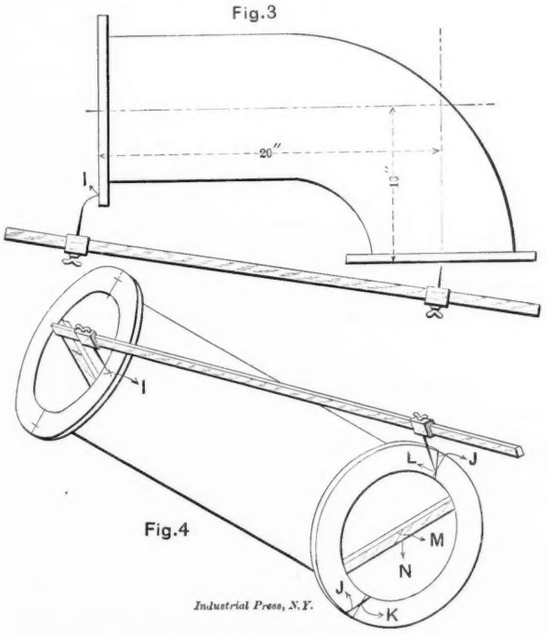


Fig. 2.

A A are scribed by the surface gage *X*, which is adjusted to 10 inches above the face of the flange resting on the table. This mark is also scribed on the stick set in the opening at the end and on which the center is to be located. From the outside of the flange the arcs *C* and *D* are struck next, from which the center of the flange is easily determined. The bolt circle *W* is next scribed 16¾ inches in diameter, cutting lines *A A* at *E* and *F*. Prick-punch marks are made at *E* and *F*,



Method of using Trammels.

and, using them as centers, the arcs *G* and *H* are struck with equal radii. The intersection *I* of these arcs gives a center on the inside edge of the flange for the trammel.

Next the ell is set up on its other flange, as shown in Fig. 2, and the line *B B* drawn by the surface gage in the same way as was the line *A A* in Fig 1. The surface gage is adjusted to scribe the line at the height of 20 inches from the flange face by using parallels. Then the lines *B B* are cut by arcs *J J*, which are drawn by means of the trammel using the prick mark *I* on the other flange as a center, in the manner shown in Figs. 3 and 4. Prick marks are made at the intersections *K* and *L*, Fig. 4, thus found, and with these as centers the arcs *M* and *N* are struck on the stick, which locate the center of the flange. From this center the bolt circle of this flange is then drawn to the diameter of 16⅜ inches.

In Fig. 2 is shown a simple way of laying out the twelve bolt-hole centers for drilling. Using the intersections *P* and *Q* as centers, the arcs *R R* and *R R* are struck with equal radii and the lines *V V* drawn through their intersections, thus bisecting the two halves of the bolt circle. Then with the intersections *Z Z* of these lines *V V* with the bolt circle and the marks *P* and *Q* as centers, the arcs *S* are struck so as to bisect the quadrants of the bolt circle at *T T T T*. Lastly, with the intersections *T* as centers, arcs of a radius equal to the radius of the bolt circle are struck, giving the eight intersections *U* with the bolt circle, and then these intersections at *U*, together with those at *T*, form the twelve equally-spaced centers for the bolt holes.

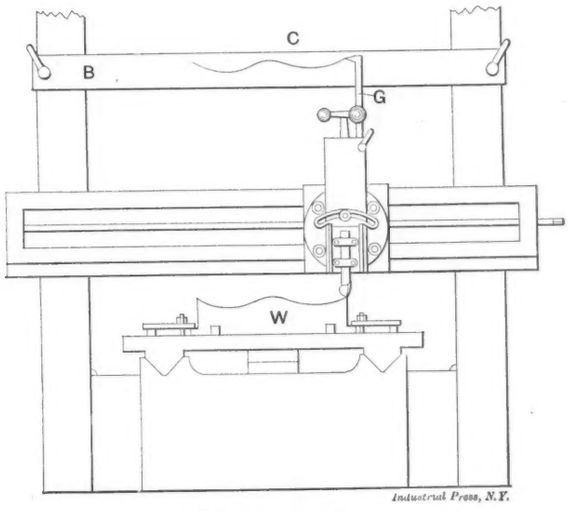
Holyoke, Mass. C. W. PUTNAM.

* * *

METHOD OF PLANING CURVES.

Editor MACHINERY:

A number of very good methods of planing curves have appeared in MACHINERY, but the accompanying sketch illustrates a method that I have used a great many times on different kinds of machines, but which I have never seen used by any



Guide for Planing Curves.

one else. It is a simple scheme, requiring very little preparation, and is not limited to short radii or to curves of any particular shape.

A board is simply clamped across the two standards of the planer, as at *B*, and upon this board is traced any curve, as *C*, to which it is desired to plane the work *W*. An ordinary surface gage may be used as a pointer by clamping it to the tool, or to the vertical feed, so that the point coincides with the curve when the desired depth of cut has been determined. Then when the planer is in operation, and the automatic cross-feed is applied, it is easy to feed the tool down at each stroke of the machine so that the pointer continually coincides with the curve on the board.

I have used this method in turning out the radii on large connecting rods, and in the railroad shop for slotting castings to fit on a boiler, where they usually furnish a template or gage and expect the operator to cut and try as best he can. This method is within the reach of an apprentice, and can, moreover, be used to advantage on the lathe, planer, or slotter for a great many jobs that do not require particular accuracy.

Bethlehem, Pa. C. H. BUCKLEY.

* * *

A PNEUMATIC PRESS.

Editor MACHINERY:

The accompanying sketches, Figs. 1 and 2, represent a pneumatic press that is in use at a railroad repair shop at

Toronto, Ont. It has proved itself a very useful adjunct to the shop for pressing in side-rod bushings, axle-box brasses, etc., so that I think it will be of interest to readers of MACHINERY.

It consists of an air cylinder *A* acting upon the ram *B*, and a dashpot cylinder *C*. The air cylinder is 30 inches long and is bored to 20 inches in diameter. The piston *D* in the air cylinder is cast in one piece with its piston rod or ram *B*, the

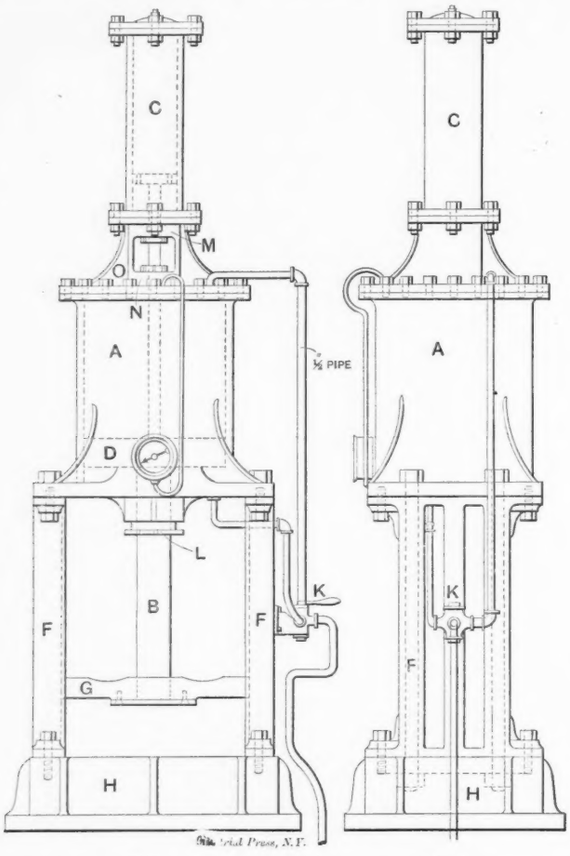


Fig. 1.

Fig. 2.

latter being bored out. The packing used on this large piston consists of ordinary snap rings. The small cylinder *C* at the top is of the same stroke, but only six inches in diameter, and is permanently filled with oil. Its piston is also of cast iron and is connected to the large piston *D* by a 1½-inch steel piston rod, which passes through the two stuffing boxes *M* and *N*. The small piston has two holes through it, as shown by dotted lines in Fig. 1, through which the oil in the cylinder passes when it is moving up or down, impelled by the large piston in its movement. Thus it acts as a cushion or dashpot to prevent sudden dropping of the heavy ram to the bottom of the cylinder when a bushing or brass has been pressed out of the work.

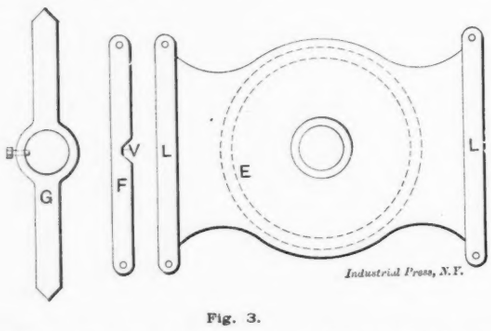


Fig. 3.

E, Fig. 3, is an end view of the lower end of the large cylinder casting *A*, showing the lugs cast on by which to fasten it to the supporting columns *F F*, Figs. 1 and 2. *F*, Fig. 3, is a cross-section view of the supporting columns *F F*, which besides acting as supports serve to guide the cross head *G* on the lower end of the ram. V-ways are planed vertically on the insides of the supports, as shown at *V*, to correspond with the ends of the crosshead *G*. These columns *F F* are bolted down to a heavy cast-iron base *H*, upon which the work rests while being operated upon, and which serves as a base for the press. A combination head *O* is used to connect the dashpot cylinder *C* to the top of the air cylinder *A*, and it is in this casting *O* that the stuffing boxes *M* for the bottom of the cylinder *C*, and *N* for the top of the cylinder *A*, are inserted. The three-way cock *K*, Figs. 1 and 2, is connected up with ½-inch pipe, so arranged that the operator can admit air pressure on either side of the piston to raise or lower it. A pressure gage is connected to the upper end of the air cylinder and located handily at the front of the press. The air pressure usually carried at the shop is 80 pounds.

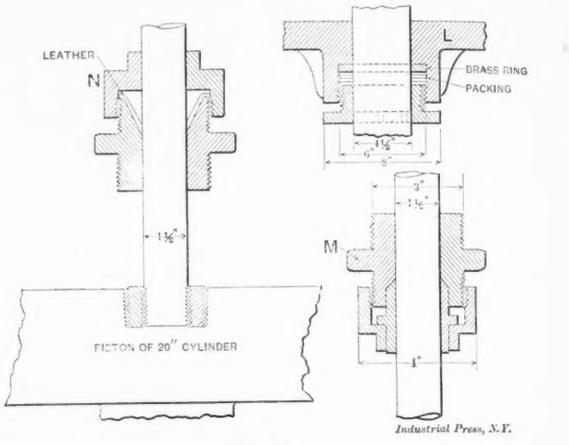


Fig. 4.

In Fig. 4 are shown in section the different forms of stuffing boxes used on the press. *N* is the stuffing box used at the top of the air cylinder *A*, in which a conical leather bucket-ring packing was found to be most satisfactory. *M* is the stuffing box used at the lower end of the oil cylinder, and *L* is the one used at the lower end of the air cylinder on the large ram *B*, which is 4¼ inches in diameter. As may be seen in the sketch, Fig. 4, *L* is packed with a flat ring packing backed up by a brass ring at the top.

With this press work can be much more uniformly fitted than by the usual methods of using a screw or, as is most frequently the case, "main strength and a sledge hammer." Also a very great saving of time is effected by its use. An interesting fact in this connection is that prior to its use much difficulty was experienced in getting a fitter to remain long on a job of fitting axle brasses, for the reason that the work was too laborious; but now no trouble of this kind is met with, the fitters in fact preferring the job of fitting to other jobs. The press will not be found to be expensive to build, especially in consideration of its usefulness.

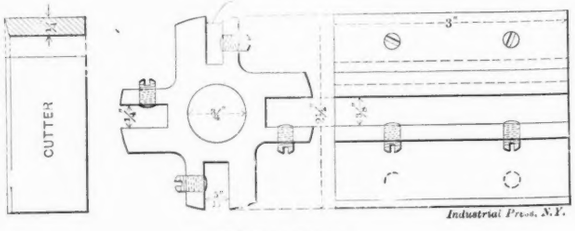
Toronto, Ont. OBSERVER.

* * *

FACING-CUTTER GRINDING FIXTURE.

Editor MACHINERY:

I am sending herewith a sketch of a fixture for grinding facing-cutters, which is a very convenient tool, as by its use one is absolutely sure to get a straight cutter. It is of cast



Grinding Fixture.

iron, and of the shape and dimensions shown in the accompanying sketch. The cutters are placed in the slots and ground the same as a milling cutter. The slots are made

of different widths to suit the different thicknesses of cutters. This tool is a time-saver over the old method of grinding by hand.

L. MEYERS.

Philadelphia, Pa.

* * *

LATHE CHUCKING DEVICE.

Editor MACHINERY:

The chucking device shown in Figs. 1 and 3 may prove of service or interest to some of your readers who have work to chuck that is difficult to hold and that must be gotten out cheaply.

The body *A*, Fig. 1, is of cast iron and is bolted to the face-plate of a turret lathe, since several operations are to be performed on the work. It is threaded with a right-hand thread at *B* to receive the ring nut *C*. The nut *C* is also threaded left hand to take *D*, which is the locking ring. The slots shown in *C* are to receive a spanner. The flange of the locking ring *D* is cut away in sections, as seen in Fig. 3, and through the openings made it receives the ring *E*, which has been similarly treated. The plate ring *F* is screwed into *E*, and is made of tool steel. The pin *G* is for the purpose of preventing *E F* from turning.

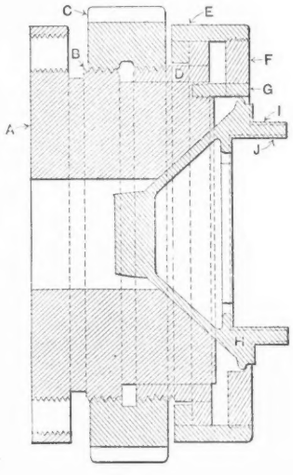


Fig. 1.

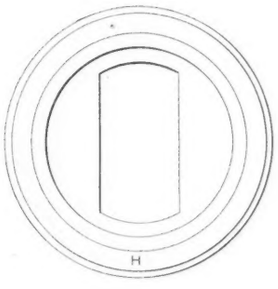


Fig. 2.

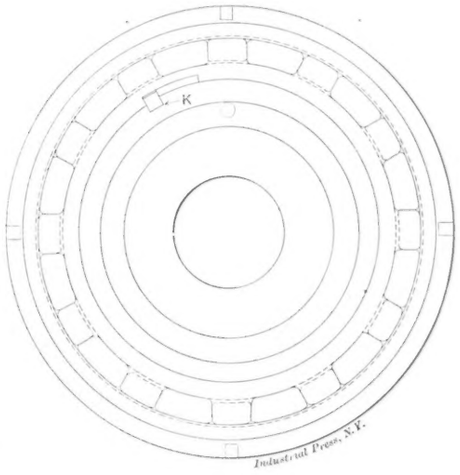


Fig. 3

Two views of the casting to be worked are shown in Figs. 1 and 2 at *H*, Fig. 2 being a front view. This casting is finished inside and out to the dotted lines shown in Fig. 1, and surfaces *I* and *J* are threaded to receive parts.

Fig. 3 shows the chuck with the casting and plate ring *F* removed.

The method of locking can also be readily seen in Fig. 3. The work is placed in *E F* and they are then entered into the chuck. The ring *C* is then turned to the right, and the friction carries *D* with it until it is stopped by the key *K*. When *D* has reached this position it locks in *E F*, and the continued motion of C draws the work firmly against the body.

Brooklyn, N. Y. J. R. GORDON.

* * *

Paper is being applied to a great variety of uses, some much more successful than others. A few years ago the paper car-wheel was widely heralded as the coming wheel for railway purposes, but now little is heard of it. Another application of this material to which attention has been drawn by an English publication with considerable enthusiasm, is that of making gear wheels. A Scottish firm is said to be making gears from this material which are quite successful, gears thus made having been run constantly for more than two years with little wear. The teeth are machine-cut and run noiselessly with metal gears, as would be expected. It does not appear that they have any advantages over rawhide or fiber gears as made in this country unless it may be in the matter of price. If paper gears can be accurately molded in a form so as to obviate machine-cutting the teeth (thus making them cheaply made) and allowing that they would be durable, there would undoubtedly be a considerable opening for them on machines using many duplicate gears where noise is an objection, as in the case of perfecting printing presses.

ITEMS OF MECHANICAL INTEREST.

NOTES GLEANED FROM DIFFERENT SOURCES.

Mr. John Tosh, master blacksmith of the C. & N. W. R.R. shops, at Boone, Iowa, gives a recipe for a hardening mixture which he recommends highly: Salt, 2 ounces; copperas, 1½ ounces; sal-ammoniac, 1½ ounces; saltpeter, 1½ ounces; sal-soda, 1½ ounces; and black oxide of magnesia, 8 ounces. The last two ingredients should be added after the others are mixed together. Before mixing the ingredients pulverize them separately, and then mix well and dry before using. Use like yellow prussiate of potash and plunge in water.

Cyanide of potash is said to be most excellent for removing rust from polished steel and iron, being used for that purpose in the United States artillery service. The rusted article should, if possible, be soaked in a solution of cyanide of potash (potassium cyanide) and water made in the proportion of one part of cyanide to four parts of water. After the rust has loosened, the article is polished with cyanide soap. The cyanide soap is made of potassium cyanide, precipitated chalk, and castile soap. Dissolve the cyanide in a little water, making a saturated solution, and then add chalk sufficient to make a creamy paste. Add the castile soap which has been cut up into fine shavings and thoroughly mix into a stiff mortar. Since potassium cyanide is a deadly poison, the mixture should be used with due caution, both as to getting it into the mouth and breathing the fumes which may arise.

The hacksaw is a tool that seems almost indispensable now and we sometimes wonder how machinists got along without it only a comparatively few years ago. Of course saws have been used to a limited extent for cutting metals practically as long as any other metal-working tools, but their general use in the machine shop began at a recent date. The modern practice of making hacksaw blades too hard to be filed and supplying them at a price so low that it is cheaper to throw away a blade when it becomes worn than to file it, has greatly contributed to the popularity of the tool. The same practice is being followed in the manufacture of butcher's meat saws, the saws being used until worn out and then thrown away. It may be of value to know that these meat saws may be used for metal saws and have been so used on repair jobs when the regular machinists' saws were not at hand. Again, these saws have a much larger range than the ordinary hacksaw which makes them extremely convenient at times.

SWEDEN'S FAMOUS IRON MINE.

For centuries the Dannemora iron ore mines in Sweden have been to the iron maker what Mecca is to the Mohammedan. It is there that the purest iron ore commercially known to man exists. The operating company is a close corporation, and the ore is sold to no one outside of it; that is, the owners all possess iron or steel producing plants, and obtain from these mines part of their supplies. They limit the

production to 50,000 tons per annum, and place it at a price which might seem prohibitory, but from its quality they can afford to so charge themselves.

The ore, which now comes from entirely underground operations, is magnetite, with an average of 50 per cent of metallic iron, and from 0.0025 to 0.005 per cent phosphorus. It requires very little flux in the blast furnace, as the gangue is principally limestone, and the phosphorus is of that minute quantity which generally leads one to doubt the chemist's reputed results.

The mine has been operated for at least 400 years. At first it was owned by private parties, but later reverted to the government. In 1863 it was again taken by individuals, and has been successfully worked ever since. Up to 1829 the ore was disrupted by fire setting. In that year the use of gunpowder was introduced. As the present working depth is 846 feet, visiting the works seems like penetrating the bowels of the earth, and when we reflect on the great age of the mine and the primitive character of its first exploiting, we could not help feeling that from some dark corner might come the spirit of the ancient Norseman to ask why we were intruding upon its original home.—Robert W. Hunt, in *Cassier's Magazine.*

GAS VS. STEAM.

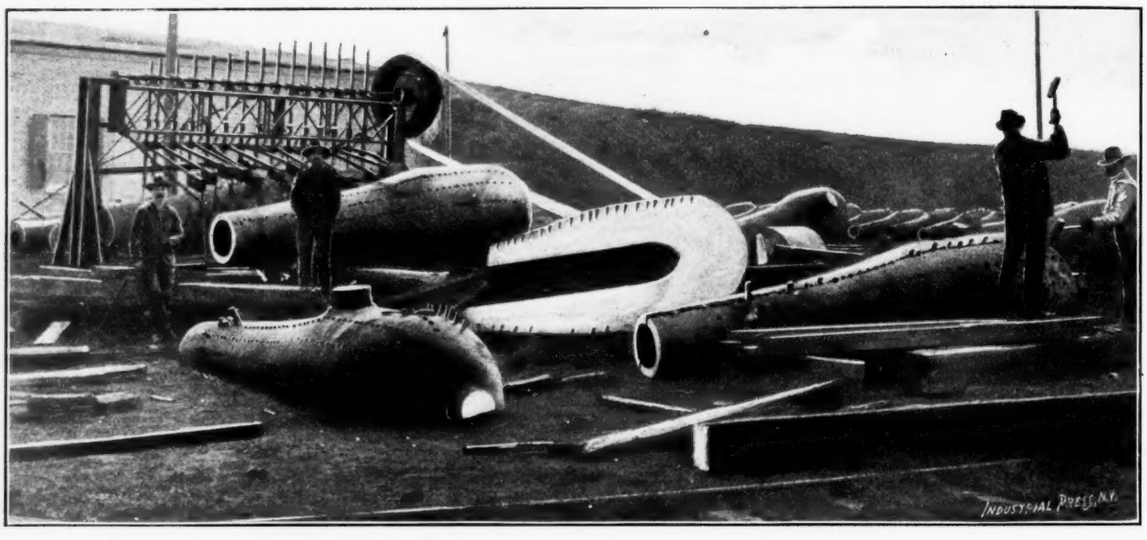
A question not yet settled to the satisfaction of engineers is whether or not the gas engine can be economically substituted for the steam engine in plants of moderate size. That gas engines are now built in sizes of several hundred horse power that run economically and satisfactorily under certain conditions there can be no doubt. But will they prove economical under the varied conditions met by the steam engine in every part of the country? On the question of economy the *Engineering News* has the following to say:

In point of fuel economy, as is well known, a gas engine of moderate size is on a parity with the largest and most completely equipped triple-expansion steam engine. Either will give a H. P. hour for each 1 to 1¼ pound of coal fed into the gas generator or boiler furnace. The remaining items are cost of plant and availability. Now that there are at least two systems (the Mond process and the Loomis process), by which power gas can be successfully made from bituminous coal, or in fact any kind of fuel, the gas engine and steam engine are everywhere equally available. The remaining question of first cost is really the vital one. We are informed that a complete gas-producer plant can be erected for 125 to 140 per cent of the cost of a corresponding complete steam boiler plant. A difference of this magnitude might easily be offset by increased economy in operation. But when we consider the engines the difference is far greater. The gas engine weighs two or three times as much as a steam engine of equal power, and the cost is in nearly the same proportion. Moreover, we are told that it is difficult to secure large gas engines in the market at the present time. The question confronting us, then, is for the gas-engine manufacturer to solve. To the conservative engineer the gas engine is, as it always has been, a very interesting machine with great possibilities, but for general large power purposes its cost is still prohibitory.

BREAKING UP FIFTEEN-INCH CAST-IRON GUNS.

Some months ago a large number of old cannon were sold at the Mare Island Navy Yard. The largest of these guns were 15-inch smooth-bore Dahlgrens of cast iron, made in the early '60's. The problem which confronted the purchasers was how to break them up into pieces of merchantable shape, which in this instance must not be larger than about 200 pounds weight.

After considering several methods and making some experiments, the contractors adopted the method of drilling rows of holes longitudinally, driving steel wedges in these holes till the guns split open, and later breaking the parts into smaller pieces with giant powder. The method of drilling and splitting the wedges is plainly shown in the illustration. The guns were jacked up on roller bearings so they could be easily revolved and a frame carrying 15 drills was set over the gun. The holes were 1 inch in diameter and about 7 inches deep. After drilling one set of holes, the drill was shifted endwise about 4 inches, and a second set of holes was drilled. In this way rows of holes about 4 inches apart were drilled entirely around the gun, the rows being spaced about 8 inches apart on the circumference. The drills were operated by a 30-H.P induction motor with current from the Yards & Docks generator.



Breaking up Cannon by first Drilling and Wedging and then Using Dynamite.

The guns were split open with steel wedges. Two men using 12-pound sledges opened one gun in a day. An effort was made to continue the splitting by wedges, but this was unsuccessful and powder was used to finish. A barricade or bulkhead of 12 by 12-inch timbers was built over the pieces and under this the segments were broken into small fragments with sticks of 40 per cent nitro-glycerine powder inserted in the holes and fired. Each gun weighed 42,000 pounds, and it required two men four weeks to drill it, and then two weeks more to break it up with wedges and powder.

One of the most interesting things in the illustration is the enormous power of the wedges. Near the breach the thickness of metal was 17 inches, and this thickness tapered to the muzzle, where it was 3 inches. A start was made near the muzzle and then as the metal cracked it was followed back until the breach opened as nicely as a hickory log. Some of these guns had never been fired, and these were much more difficult to break up than others.

[The above account was contributed by Frank H. Green to the *Engineering News*, to which publication we are also indebted for the photograph from which the illustration was made.—EDITOR.]

NEW TOOLS OF THE MONTH.

Under this heading are listed new machine and small tools when they are brought out. No tools or appliances are described unless they are strictly new and no descriptions are inserted for advertising considerations. Manufacturers will find it to their advantage to notify us when they bring out new products, so that they may be represented in this department.

The Cincinnati Milling Machine Co., Cincinnati, O., have brought out a vertical spindle milling head for use on heavy knee-type milling machines. The spindle runs in adjustable boxes and its end is threaded on the outside the same as the end of the horizontal spindle of the No. 3 and 4 machines made by this company. It also has the same size taper hole, so that all tools are interchangeable between the horizontal and vertical spindles. The head can be swiveled in a vertical plane through 360 degrees and is graduated.

J. T. Slocomb & Co., Providence, R. I., have recently brought out a micrometer caliper in modified form, designed for measuring the thickness of the walls of tubes, and similar work. It is also useful to tool makers on jig work, in testing distances of holes from the edges of a piece of work. The principal parts of the caliper are like the standard one-inch Slocomb micrometer caliper, but the outer end of the frame which carries the anvil is beveled so as to reduce the width of the frame at this point and allow the anvil to enter the tube or hole. Since the anvil of the Slocomb caliper is practically solid with the frame, the adjustments being made at the other end, it is an easy matter to so shape the anvil as to adapt it for special purposes. In this case the frame is made narrow enough to allow the anvil to enter a hole 7-16 inch in diameter and to a depth of ¾ inch. The anvil itself is spherical on its end, so that it will bear correctly against the cylindrical surface of a hole.

IMPROVED DRILL SOCKET.

A new drill socket is now manufactured by the Cleveland Twist Drill Co., Cleveland, Ohio, the leading feature of which is the shape of the slot in which the drift pin fits. In the usual form of socket the drift pin bears on the corner of the drill tang, and the workman must hold the drift with one hand while he strikes it with the other, and he needs three hands if he wishes to prevent the drill from falling out and striking the drill table or the work. In the new socket the drift will stay in position, whether it is hit hard or lightly, and one hand is free to hold the drill. The drift rests squarely upon the top of the tang of the drill, and it can be driven in from either side of the socket, the double bevel making the drift fit equally well either way.

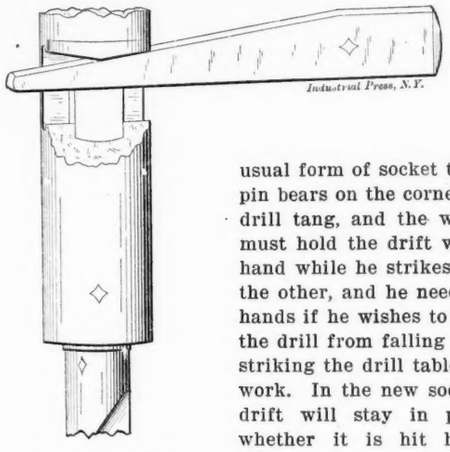


Fig. 1. Drill Socket.

DRILL VISE.

A drill vise with a universal jig attachment is a new and novel accessory manufactured by the Graham Mfg. Co., Providence, R. I. This style of vise is made in three sizes and they are intended to be used either with or without the jig attachment. A drill vise is one of the most labor-saving features that can be applied to a drill press, since it provides means for quickly clamping or releasing work, and as it can be moved about on the drill press table, avoids the necessity for shifting the arm or table of the drill press.

The jaws of the vise are faced with unannealed cast steel. It has been found by experiment that the quickest method for releasing or clamping the work is by a coarse pitch screw, and this is used in preference to some quick movement device for the movable jaw. The jig attachments are intended for duplicate drilling, thereby saving the time and trouble of laying out work and also preventing the drill creeping to either side. The way to use the jig is to lay out and drill one piece, and paint this red or some unusual color; this being understood to be a sign that it is not to be used, but to be kept for a sample or template to set up the jig by when similar pieces can again be drilled without marking off or using the draw chisel.

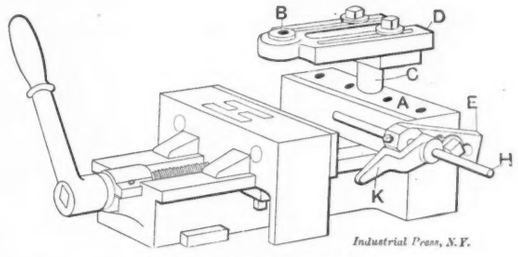


Fig. 2. Drill Vise and Jig.

The following letters refer to parts marked to correspond on the engraving:

B is one of several interchangeable bushings with interior holes of different sizes, but common outside diameter. *D* holds this bushing and may be swivelled to any desired position. It may and will generally be used without holder *C*, that is, firmly secured to vise proper at *A*. *C* is the bushing holder stand. It is movable up and down and can be made to swivel. It is held by a clamping device, not shown in cut. *E* is a movable fixture to hold stops. *H* and *K* are movable pieces and the immediate stop against which the work is brought.

HORIZONTAL MILLING MACHINE.

The Becker-Brainard Milling Machine Co., Hyde Park, Mass., have recently brought out a Lincoln type milling machine. The table is heavy, with feed automatically tripped at any position in the entire length of the longitudinal feed, and has a transverse adjustment of 5 inches, with a quick-return handwheel conveniently located. It has three slots of standard size, and is provided with oil pockets on each side and end. The spindle, of hammered crucible steel, runs in self centering adjustable bronze boxes, is back-geared 6 3-10 to 1, has a No. 10 B. & S. taper, and is mounted on a heavy carrier accurately scraped to the head and firmly held with four bolts, having a

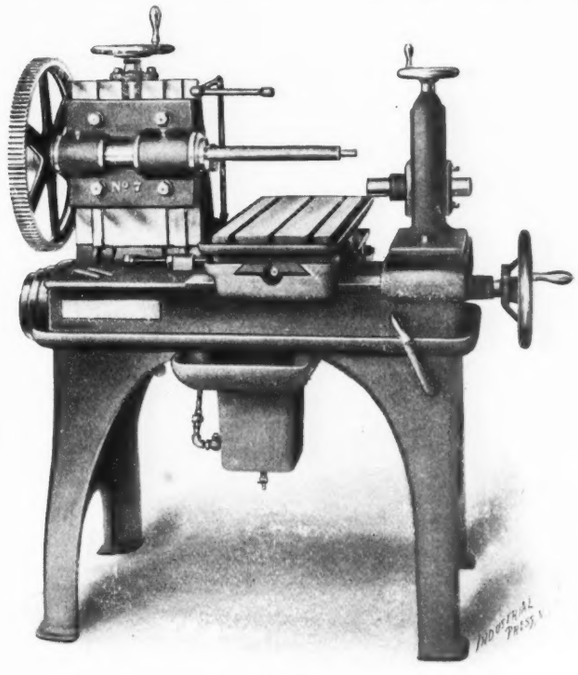


Fig. 3. Becker-Brainard Milling Machine.

bearing 13 x 11 inches on the face. The spindle carrier is supported upon the upright column, is elevated by a single screw with micrometer adjustment, and is also provided with a stop screw to enable the operator to return the spindle to exactly the same position. It is gibbed its whole length to take up any wear, which insures accurate alignment. The design of the bed in the upright column is similar to that on the heaviest types of long feed machines, thus giving absolute rigidity. The steel feed worm is attached to the carriage, runs in oil pockets and is splined to the feed shaft to overcome any side thrust. The tail post is adjustable to take different lengths of arbors and has a hardened steel tail center, also adjustable. The machine is provided with a complete oiling apparatus when desired. The vertical adjustment of the spindle is 8 inches; the diameter of spindle 2½ inches; number of steps on cone, 3; the largest step on cone, 10 inches; the smallest step, 6 inches; number of feeds for each speed, 4; and width of belt, 2½ inches.

BESLY BAND GRINDER.

The Besly Band Grinder, made by C. H. Besly & Co., is a neat and efficient form of polishing machine, and in Fig. 4, is shown a new type of this machine, so designed that an operator can use it when sitting down. It is also built with the usual upright pedestal. The band wheels are made of semi-steel castings and the emery or other abrasive material is applied to the wheel on a cloth band which is slipped on to the wheel. The two ends of the band pass through a slot in the periphery of the wheel, and are drawn tight by a special device on the inside of the rim. To reset the wheel

Fig. 4. Band Grinder.

it is only necessary to remove a band and replace it with another. Felt covered wheels are furnished, if desired, and are to be used when a soft polishing surface is necessary. The band of cloth carrying the abrasive is then fastened on the outside of the felt. One of these machines equipped with an assortment of bands will do the work of an ordinary buffing and polishing frame, and makes it unnecessary to have a large and expensive assortment of wheels.

A NEW RADIAL.

The Bickford Drill and Tool Co., Cincinnati, O., have brought out an entirely new design of radial drill from designs and patents of H. M. Norris, their works manager. Three sizes and four styles of this machine are now being built, the smallest of which is illustrated. The machine has a large number of speeds and feeds. Directly connected with the feed mechanism there is a dial depth gage that enables the operator to read all depths from zero instead of between intermediate points on a fixed scale; the traverse of the spindle is controlled by an absolute safety stop; the tapping device operates at all speeds; and the machine is provided with a multiple automatic trip, which at one setting can be made to trip the feed at as many different depths as there are holes in the work being done, this being one of its most novel features. In place of the usual cone there is a single drive pulley from which power is transmitted through what the manufacturers call the speed box, mounted on the base at the left of the column. This box contains gears and friction clutches, which by means of one lever can be made to give any one of four speeds. As compared with the customary cone pulley drive, the advantages claimed for this speed box are that it does away with all belt shifting, can be driven from below the floor, can be driven by a quarter twist belt if desired, and is well adapted to the application of electric motor drive.

From the speed box the power is transmitted through mitres to a back gear box mounted behind the column on the arm sleeve. This is practically a second speed box, for it

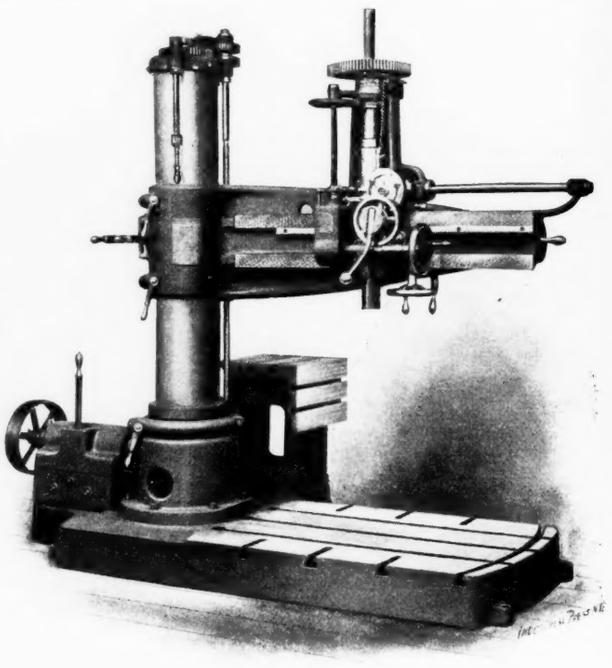


Fig. 5. Bickford Radial Drill.

contains gears and friction clutches, which by means of the two levers shown at the far left of the arm give four speeds, the varieties being so arranged as to give in combination with the speed box proper 16 spindle speeds in geometrical progression, ranging from 16 to 266 revolutions per minute.

The feed range is from .005 inch to .1 inch per revolution of spindle, the operating gears being so related as to divide this range into 8 feeds in geometrical progression. The feed gears are mounted in a box on the head to the left of the drill spindle, and are operated by a lever, a quarter turn of which changes the feed either to the next higher or the next lower.

It will be seen that the speed, back gear and feed box levers give the operator instant and easy control over the cutting tool, one speed and feed being just as easy to get as any other, so that in this machine there would seem to be no sense whatever for not running every drill at its proper speed and feed, especially as engraved index plates, fixed to the machine, indicate the positions of the several levers and the proper speeds and feeds for all diameters covered by the range of the machine.

FIFTY-TWO INCH BORING MILL.

One of the new machines exhibited at Buffalo by the Prentiss Tool and Supply Co. was the 52-inch screw-cutting, boring and turning mill manufactured by the Rogers & Hemphill Machine Co., Alfred, N. Y. The machine is illustrated in Fig. 6 and has a number of new features. The housings are of the box type and extend clear to the floor. The cross-rail is raised or lowered by power and carries two heads, and all the bearing surfaces upon the rail and in the saddles and heads are unusually large. Accurate graduations are provided for the heads.

The table has 16 T-slots and can be stopped at any desired position by means of the brake in connection with the foot lever shown at the side of the base. The table gear and pinion are accurately planed and the teeth are protected from chips. Each head is entirely independent of the other in respect to its feeds, etc.

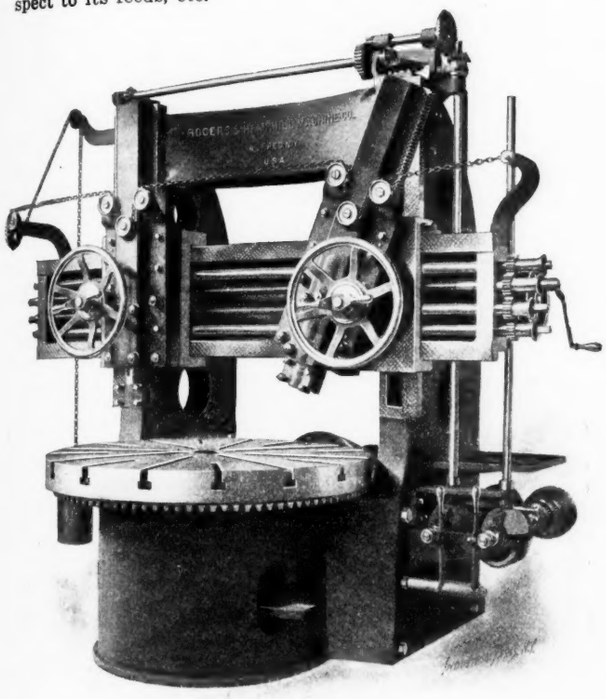


Fig. 6. Fifty-two Inch Boring Mill.

The feeds are positive and are operated by cones of gears. They are designed with special reference to thread cutting, and all standard threads can be cut from 2 to 12 per inch, including 11½. This is a great convenience in the case of large flanges and similar work which has to be threaded, since they can be finished complete on the mill and need not be removed to a lathe for threading.

THREE-WAY FACING MACHINE.

The Beaman & Smith Company, Providence, R. I., beside manufacturing a number of standard machines, particularly milling and boring machines, design and build a great many special tools. One of the recent machines of this character

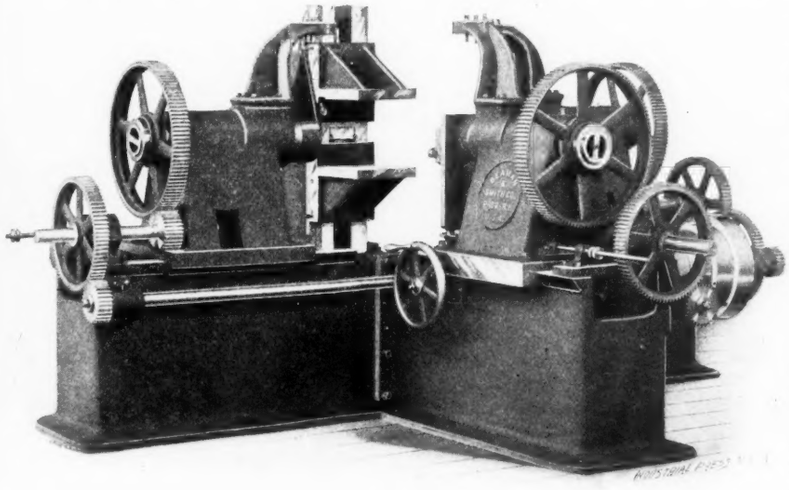


Fig. 7. Three-way Facing Machine.

is a three-way facing machine shown in Fig. 7, adapted for facing simultaneously three sides of a casting such as pipe fittings, or any work requiring three sides to be machined, with the adjacent sides at right angles with one another. There are three heads mounted on suitable beds, each of which is provided with independent adjustment and carries a spindle of large diameter running in hard bronze boxes. The spindles are driven in unison by a 4-inch belt on a four-section cone, through gearing, in the ratios of 11½ and 38½ to 1. At the front end of each spindle is attached a facing head provided with a saddle-carrying tool and with automatic feed in either direction by means of a star wheel and kicker pins, and capable of facing to 24 inches diameter. The least distance between the two heads is 10 inches and the greatest, 40 inches; while the other head is placed at a right angle to the others with equal adjustment from a common center. The work is held in suitable fixtures fitted to a two-jawed chuck or vise, forming a part of the machine. The chuck is mounted on a carriage supported by a bed and has a horizontal movement, by means of rack and pinion, for the purpose of conveniently placing and removing the work.

NEW DOWN-DRAFT FORGE.

In the accompanying cut, Fig. 8, is shown a new type of down-draft forge adapted for heavy work, such as is met with in railroad repair shops and other situations of a like

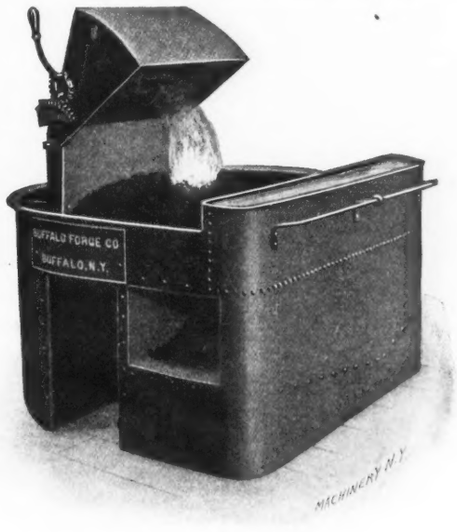


Fig. 8. New Buffalo Forge.

nature. As will be perceived, the forge is constructed of steel plate of a heavy gage with cast iron exhaust hood and connections. Blast gates are attached to the forge with levers for controlling the blast, and the Buffalo anti-clinker dumping tuyere permits ready cleaning of the fire without undue disturbance of the same. As will be noted, a convenient water tank is provided, as well as a novel coal hopper in the body of the forge itself. The hood is adjustable to various positions at the fire, so that smoke and gases may be efficiently exhausted under all conditions. The forge is manufactured by the Buffalo Forge Co., Buffalo, N. Y., who have made a specialty of down-draft forges, doing away with overhead piping, and the heat and smoke so prevalent in many forge shops.

TWIST DRILL GRINDER.

The Standard Tool Co., Cleveland, Ohio, have brought out a twist drill grinder, shown in Fig. 9, which is adapted for drills from ⅛ to 2¼ inches in diameter. It will grind right or left-hand drills, flat drills, two, three or four-lipped drills or three-groove chucking reamers. A geared pump with supply tank is fitted to the machine, giving a continuous feed of water on the wheel. When the machine leaves the factory it is set to grind at an angle of 59 degrees, but it can be adjusted to grind a wide range of angles, both above and below 59 degrees. The various adjustments for drills of different sizes and angles are easily and quickly made, and are as follows:

First, place the drill in *V* drill holder, and screw up drill stop *A* until the tip of the drill extends about 1-32 inch ahead of drill guide *B*. Second, loosen the clamp on the right side, and move handwheel *C*, on the left side with the brass dial up to a point indicating the size of the drill; then tighten the clamp on the right side. Third, turn the handwheel *D* under the machine until drill guide *B* comes to within 1-32 inch of the face of the emery wheel; then tighten side handwheel *H* to hold rigid. Turn the knurled screw head *G* for grinding

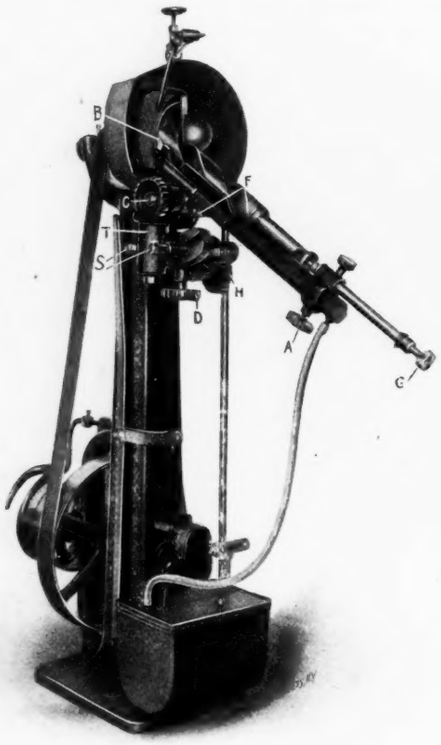


Fig. 9. Standard Twist Drill Grinder.

off stock on the tip of the drill. For more or less clearance, loosen setscrew *F* underneath the *V* drill holder, and move either right or left until the proper clearance is obtained; then tighten the setscrew. For more or less angle, loosen the two screws *S* on the taper bearing, and move the *V* drill holder up or down until the angle required is obtained; then tighten the T-slot screws. Corresponding marks on the taper bearing indicate the proper position of the machine for grinding an angle of 59 degrees.

PLAIN MILLING MACHINE.

A plain milling machine, new in design and known as No. 24, has recently been brought out by the Brown & Sharpe Mfg. Co., Providence, R. I. Several important features that have not been combined before in a machine of this size and capacity are embodied in its construction.

The machine is built for work requiring unusually large table capacity and long cuts. Exceptionally heavy gearing is provided, thus fitting the machine especially for the requirements of machine tool builders, engine and railroad shops, and the heavier class of milling in general.

The following details relative to its construction may interest our readers: The steel spindle has ground and lapped bearings and runs in phosphor bronze boxes, provided with means of compensation for wear, and is driven by a worm wheel, the worm wheel being made of phosphor bronze, while the worm is made of steel, hardened, and runs in oil. The thrust of the worm is taken by ball bearings. Provision is made for taking up the wear of the worm and wheel, thus insuring proper contact and the smooth running of the spindle.

The spindle cone runs idle and in the same direction as the shaft on which it is mounted, thus reducing the friction to a minimum. It has only two steps; the power being transmitted through a system of gearing, arranged to give an exceptionally high ratio.

The changes of spindle speed are obtained by means of transposing gears. With two speeds of the countershaft, 8 changes of speeds are obtained, varying from 15 to 100 revolutions per minute. The advantages of this method of driving are readily appreciated, as the speed of the spindle cone is maintained more uniformly than when the changes of speed are wholly dependent upon the number of steps in the cone, and the power is not reduced to as great an extent when slow speeds are required for heavy cuts.

The method of clamping the spindle head and knee is improved, each being clamped by one lever in place of two, as formerly. This will tend to show the care and attention given throughout to the details of convenience in the manipulation of the machine.

The arm support is exceptionally rigid and of improved design. It is made in two parts, clamped directly to the front of the knee, and can be easily placed in position or removed. The two parts slide upon each other, and are clamped in position by bolts passing through the slots. This form admits of a bearing for the outer end of the arbor directly in the support, and allows the adjustable arbor support to be used at any intermediate point in the arbor.

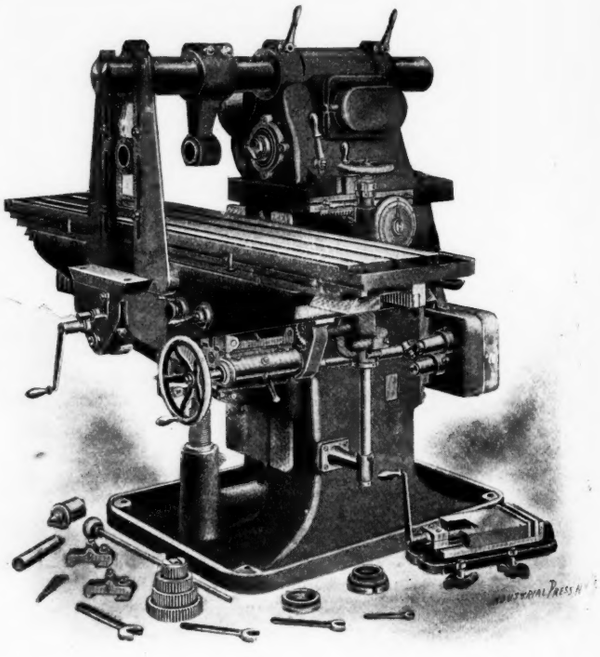


Fig. 10. New Brown & Sharpe Milling Machine.

The table is supported directly in the knee, which is very long for the capacity of the machine. Another important feature to be noted is that the table remains locked in position when the feed is automatically thrown out. Adjustable dials, graduated to read to thousandths of an inch, indicate the longitudinal, transverse and vertical movements of the table. A dial, graduated to read to 64ths of an inch, indicates the transverse movement of the head.

AXLE TURNING LATHE.

One of the new machines that is being manufactured by the Grant Tool Co., at their new plant, at Franklin, Pa., is a 10-inch car axle lathe, shown in Fig. 11. It is an unusually powerful and massive machine, even for the class of work for which it is designed, and it swings 8 feet 2 inches between centers and 10 inches over the carriages. The carriages are guided on the bed by a V-track on the front, having a surface of over 4 inches, and at the rear by a flat surface of about the same area. They are fitted with tandem tool posts and are self oiling. The right-hand tail-block spindle is moved by a worm and worm wheel gearing, and it can be operated on either side of the lathe. The clamping device is positive, preventing the tail block from sliding back from the work. The cross feed screws of the carriage are geared three to one, making it easy to adjust the tools when necking into the

work or in cutting off stock.

Aside from the massiveness and great power of the machine, the chief features are the method of driving the work and the arrangement for placing the work in the machine, or for removing it. As usual in such lathes, the driving head is at the center and consists of a gear with a large hub running in suitable bearings. There is a large hole through the center of the gear, through which the work passes, the driving being by means of suitable dogs or clamps. The general arrangement of the driving head is shown in Fig. 12, where *G* is the driving gear, having the hubs *a* and *b*, which support the gear in its bearings. A segment is cut out from this gear, as shown at *S*, and when the gear is in such a position that this opening comes opposite a corresponding opening in the gear casing,

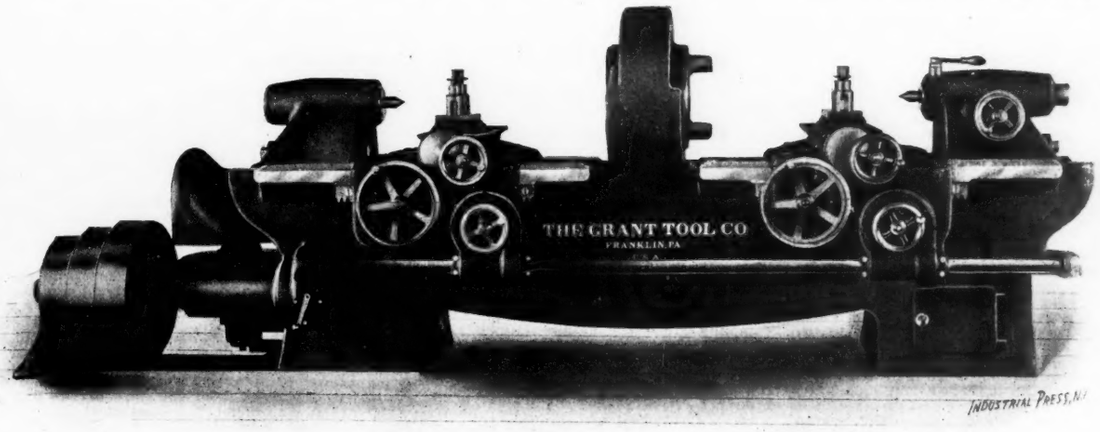


Fig. 11. Grant Axle and Forging Turning Lathe.

an axle can be rolled into place between the centers or can be rolled out of the lathe when finished, without having to pass it through the gear, end first, in the usual way. Since cutting out this segment makes a break in the continuity of the teeth of the gear, a special driving arrangement is provided. The driving shaft is at *T*, and the pinion *D* at its end drives two idler gears *I I*, both of which mesh with the main gear. These idlers are separated enough so that when one idler is out of contact with the driving gear, owing to the section where the segment is cut out, the other idler will do the driving. In the sketch the right-hand idler is just passing out of contact at point *x*, and the other one has passed into

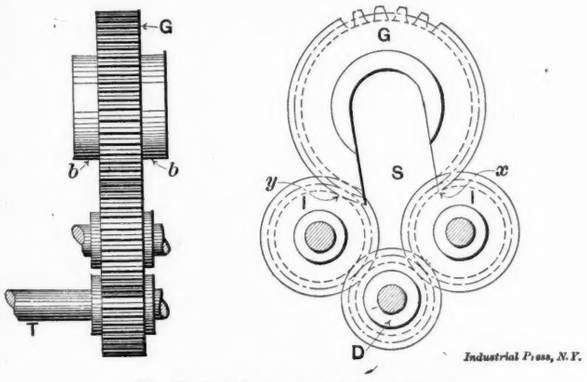


Fig. 12. Driving Gear and Connections.

contact at point *y*, thus giving a continuous and uniform motion to the driving gear. The shaft *T* is driven from the cone pulley through a worm and worm wheel and two bevel gears, encased at the left end of the machine, as in Fig. 11.

The arrangement operating the feed-rod is very simple, having less than one-half the number of pieces generally used in axle lathes, is positive in action, and quickly adjustable for any variation of feed from 1-16 to 3-16 per revolution of axle.

* * *

The first electric railroad in Russia has been opened this year. It is 13½ miles long, and connects the manufacturing city of Lodz, in Russian Poland, with neighboring towns.

FRESH FROM THE PRESS.

ELECTRIC IGNITION FOR GAS, GASOLINE AND OIL ENGINES. By Harry B. Maxwell. Published by the Maxwell Engineering Co., Rome, N. Y. Price, $1.00.

There are two principal methods of electric ignition, namely the primary or hammer-break spark and the secondary or jump spark method. In this pamphlet there are working drawings for successful devices for both methods, and which are stated to infringe no patents and are free to be used by all. There are four pages of text explaining the drawings and ten plates giving full details.

LINEAR DRAWINGS AND LETTERING FOR BEGINNERS. By J. C. L. Fish, Assoc. Prof. Civil Engineering in the Leland Stanford, Jr., University. Published by the author at Palo Alto, Cal. Price, $1.00.

This book is intended to furnish the student enough training in the use of drafting implements to enable him to construct accurate pencil drawings, make clean-cut ink lines and do legible lettering. It embraces the instruction given by the author as preparation for drafting in courses in descriptive geometry, machine drawing and surveying. There are four folding plates and the instruction as to the use of the instruments, irregular curves, triangles, etc., is given in great detail, both in the text and by suitable illustrations. The subject of lettering is also treated very fully, not only taking up the form and proportion, but also pointing out the difficulties met with by a beginner. Accompanying the text-book is a blank book containing 32 pages suitably ruled for practice in lettering. The price of this is 25 cents.

HOW TO BUILD A THREE HORSE POWER LAUNCH ENGINE. By E. W. Roberts. Folio size, with numerous plates. Published by the Gas Engine Publishing Co., Goodall Bldg., Cincinnati, O. Price, $2.50.

The object of this book is to furnish a design for a complete gasoline launch engine, together with the necessary instructions for its construction. In proportioning the various parts the rules given in the author's "The Gas Engine Handbook" have been followed, and in order that the formula may be looked up in any particular instance, references to the handbook are given in the text. In preparing this work the author has first made a complete set of shop drawings, nearly all of them full size, and then reduced the drawings to make the plates in the book. Details are given for all the parts, with full dimensions, and assembled drawings are shown where necessary. The engine has been designed so that it may be built with the tools found in the average machine shop, no piece except the flywheel—which is 18 inches in diameter—requiring a lathe larger than 16-inch swing. This is a four-cycle engine, because it is the author's experience that machinists who have had no experience with two-cycle engines are not successful with them. The book is attractively gotten up and the drawings are clear. Blueprints from the original tracings can be furnished, if desired, at an additional cost of $4, when purchased with the book, or $4.50 when bought separately.

COMPRESSED AIR, ITS USES AND APPLICATION. By Gardner D. Hiscox, M.E. Published by Norman W. Henley & Co., 132 Nassau Street, New York. 822 8vo pages, with 545 illustrations. Price, $5.00.

Mr. Hiscox is the author of the well-known books, "Mechanical Movements," "Gas, Gasoline and Oil Engines," "Horseless Vehicles," etc. This, however, is much the most important work that he has produced and is the most complete and comprehensive treatment of the subject of compressed air and its applications that has been published. In fact, we know of no other book which does more than treat the subject in a fragmentary manner. The literature on the commercial uses of compressed air, especially in its application to the mechanic arts, has consisted almost entirely of trade circulars and occasional articles and papers published at different times. There has also been much matter published on the theoretical side of the subject in books upon thermodynamics and in papers presented before engineering societies. This scattered information, however, does not meet the requirements of the engineer, who needs to have his information gathered together in convenient form for reference. As contributor of the *Scientific American*, Mr. Hiscox has had the chance to gather a large amount of information upon compressed air and its applications and this has been preserved and utilized in the preparation of this book.

The scope of the work may be judged by the following statement taken from the title page: The book contains matter upon the physical properties of air from a vacuum to its liquid state, its thermodynamics, compression, transmission and uses as a motive power in the operation of stationary and portable machinery, in mining, air tools, air lifts, pumping of water, acids and oils; the air blast for cleaning and painting; the sand blast and its work; and the numerous appliances in which compressed air is a most convenient and economical transmitter of power; for railway work, railway propulsion, refrigeration and the various uses to which compressed air has been applied. A great many of the illustrations were made especially for this work, while others which illustrate compressed air machinery and devices are taken from trade literature, the effort being made to select such ones as represent the best modern practice in all departments. The book is printed on coated paper and its appearance is exceptionally good. There are in all 36 chapters, with a list of patents upon compressed air devices. The theory of the subject is treated fully and such allied subjects as air applied to pyrometry,

liquid air, pneumatic tube transmission air compressors at high altitudes, the power of the wind, etc., are touched upon. A great deal of attention is given to air compression and to pneumatic tools. Air pressures both below and above atmospheric pressure are considered. There are forty tables for convenient reference and the book impresses us as a very valuable treatise in which sufficient attention is accorded both theory and practice to make a well-balanced book.

ADVERTISING LITERATURE.

We have received the following catalogues and trade circulars:

J. M. KING & Co., Waterford, N. Y. Price list of tools such as taps, dies, pliers, diestocks, etc.

THE WATSON-STILLMAN Co., New York City. Catalogue No. 61, of hydraulic jacks, of which this company make an extensive line. These are made in a great variety for all uses to which such machinery is applicable.

THE STANDARD PNEUMATIC TOOL Co., Chicago, Ill. Illustrated circular of the "Little Giant" pneumatic hammers in which are descriptions of the different sizes of hammers, and illustrations showing them in actual use on different kinds of work.

THE HOGGSON & PETTIS MFG. Co., New Haven, Conn. Catalogue of the Sweetland chuck and also of tool holders, surface gages and other machinists' tools, steel stamps for both letters and figures, tool room and time checks, etc.

THE PECK DROP PRESS WORKS, New Haven, Conn. A circular containing useful information and a table enabling one to calculate the relative effects produced by drop hammers falling from different heights. The table is a useful one in estimating the capacities of hammers and will be sent to any address upon application.

THE AMERICAN TOOL WORKS Co., Cincinnati, O. Fifth edition of their catalogue of machine tools. In this catalogue are listed the extensive line of tools made by this company, and as the catalogue is pocket size and contains numerous useful tables, it is convenient for reference. An attractive circular has also been issued upon their Pan-American exhibit.

THE CLEVELAND PNEUMATIC TOOL Co., Cleveland, O. Catalogue of pneumatic hammers, drills and other pneumatic appliances. The tools and appliances made by this company are illustrated, and there are numerous reproductions from photographs showing the actual operation of these tools in the machine shop and on structural work.

THE GRANT TOOL Co., Franklin, Pa. Catalogue of machine tools. This is the first catalogue issued by this company since the establishment of their new works at Franklin, Pa. It is handsomely gotten up and the tools listed include several sizes of hand lathes, a taper-turning lathe, a 16-inch engine lathe, several sizes of turret lathes, upright drills, boring machines, milling machines, worm-wheel hobbing machines and an axle lathe of novel construction.

THE B. F. STURTEVANT Co., Boston, Mass. Catalogue of the Sturtevant steam hot blast, heating and drying apparatus and dry kilns. The Sturtevant system of heating by a hot blast has been applied so extensively in the machine shops of the country that it requires no description. In addition to treating of this subject the catalogue contains much valuable information and gives many practical hints upon dry kilns and the process of drying, while incidentally the kilns and apparatus supplied by the Sturtevant Co. are described.

THE LONG & ALLSTATTER Co., Hamilton, O. Catalogue No. 20, of power punching and shearing machinery. This catalogue contains 160 pages, on nearly every one of which is an illustration and a description of the punching and shearing machinery of the various sizes and styles made by this company. This statement gives a good idea of the extensive line of machines which they manufacture, some of which are for the very largest and heaviest work, such as is met with in heavy boiler work and in structural work.

THE CHICAGO PNEUMATIC TOOL Co., Chicago, Ill. Catalogue No. 15 of pneumatic tools and appliances. This catalogue contains an unusually large number of illustrations from recent photographs showing the tools of this company at work on some of the most noted buildings and on other structural work. Among the noted structures are the new East River Bridge, the glass furnaces at Denver, Colo., the Boston Elevated Railroad, battleships of the navy, the State Capitol of Minnesota, etc. In point of variety, showing the many uses to which compressed air can be applied, these illustrations form the most comprehensive group we have seen, and the catalogue is exceptionally attractive in appearance.

THE MASSACHUSETTS TOOL Co., Greenfield, Mass., inform us that they have purchased the entire mechanical tool business of Coffin & Leighton, Syracuse, N. Y., including their machinery, stock, fixtures, patents and good will. They will shortly install the same in their factory and be in a position to supply the wants of their friends. All orders for articles of Coffin & Leighton make should be sent to the Massachusetts Tool Co. to avoid delay. They will soon issue a complete catalogue wherein will be shown tempered steel rules, protractors, surface gages, micrometers and various other instruments of precision of a like or similar character.

THE NORTON EMERY WHEEL Co., Worcester, Mass. Illustrated catalogue of emery and corundum goods and grinding machinery. The emery and corundum wheels, emery bricks, etc., made by this company comprise an extensive line adapted to every use to which abrasive materials are now applied. This is a large catalogue containing in addition to a description of their products much useful information. A complete line of polishing and grinding machines is shown, and attention is given to the Walker universal tool and cutter grinder which they manufacture, and the large plain grinding machine made by the Norton Grinding Co. There is also listed the Bath test indicator and a grinding attachment for engine lathes.

MANNING, MAXWELL & MOORE, New York. Illustrated catalogue of railway, steamship, factory and machine shop supplies and tools. This is the largest catalogue issued in the trade, having over 1,000 large pages. The line of machinery, tools and supplies carried by this company is so extensive that two principal catalogues are published, one of which is for metal and wood-working machinery and the other, which is under review, illustrates their line of railway, steamship, machinists' and contractors' tools and supplies. In the matter of small tools, shop, mill and factory supplies, from the motive power to the smallest accessories, this catalogue will be found a convenient guide. There is also an extensive list of electrical apparatus. The catalogue is so extensive that it is impossible to refer to it in a notice of this description except in a general way. It is so well-known in the trade that it is unnecessary to do more than say that this year's issue is even more complete than the preceding ones.

MANUFACTURERS' NOTES.

J. T. SLOCOMB & Co., Providence, R. I., announce that they have adopted the nine-hour day with ten hours pay.

THE BOWEN MFG. Co., Auburn, N. Y., have recently installed in their works two car loads of machinery, a large proportion of it automatic.

THE ARMSTRONG BROS. TOOL Co., Chicago, Ill., have lately received an order from the Mexican Central Railway Co., Ltd., for over 200 Armstrong tool holders, mostly of heavy sizes, and for a large quantity of steel for use in same, the order amounting to over $1,000.

THE ROLLER BEARING & EQUIPMENT Co., Keene, N. H., announce that they have just had eleven grinding machines added to their equipment, with several more on the way, to enable them to give their many friends quicker deliveries and avoid night work in their factory.

THE STANDARD PNEUMATIC TOOL Co., Chicago, Ill., have removed their general offices from Chicago to their new works at Aurora, Ill., where all correspondence should be addressed. They have also greatly increased their facilities for manufacturing, which will enable them to fill orders promptly.

THE NILES TOOL WORKS Co., Boston, Mass., announce that the Boston office of that company, of Bement, Miles & Co., and of the Pond Machine Tool Co., has been removed to 144 Pearl Street, where Mr. Chas. H. Kingsbury, the local manager of the above companies, will be pleased to meet all consumers of the product of the above tool manufacturers.

THE CLEVELAND TWIST DRILL Co., Cleveland, O., announce the opening of a store at 17 South Canal Street, Chicago, where will be carried a full and complete stock of all the goods of their manufacture for the convenience of the trade of Chicago and vicinity. This stock will be in charge of Mr. John G. Ladrick, who has represented them in the West for a number of years.

THE CINCINNATI MILLING MACHINE Co., Cincinnati, O., made an export shipment of milling machines on October 26th to the following foreign points: Manchester, Liverpool and London, England; Brussels, Berlin, Vienna, St. Petersburg, Paris and Japan. This would seem to indicate that the foreign demand in some lines of machine tools is considerably alive.

AN interesting round house is that of the Lake Shore road at Collinwood, O. This house, having a turntable 72 feet in diameter, is one of the largest ever built. It is heated throughout by the Sturtevant system, the hot air being discharged to the locomotive pits and serving as it rises to rapidly melt the snow and ice from the running gear. This method is coming into general use in all new buildings of this character.

THE entire interests of the Acme Machine Screw Co., Hartford, Conn., have been sold to the National-Acme Mfg. Co., Cleveland, O. Until further notice orders will be accepted and executed as heretofore by the Hartford factory. A new factory is being built in Cleveland which will be ready for occupancy early in 1902. The National-Acme Mfg. Co. will manufacture the Acme multiple spindle screw machine and a full line of cap screws, setscrews and special milled work turned from steel, iron, zinc or brass.

THE AMERICAN DIE & TOOL Co., Reading, Pa., reported to us early in November that on the 8th of that month they had lost by fire their hardening and tempering department. They added that they expected to be somewhat inconvenienced while they were rebuilding, but that their many customers would not be compelled to wait longer than about a week or ten days from the date of the fire. No doubt by this time they are in running order once more.

E. G. SMITH, Columbia, Pa., writes us that owing to the use of improved machinery, i.e., automatic screw machines for the manufacture of his "Which Way" pocket levels, he is now able to produce them at a much lower figure, and that he has reduced the price of them to 50 cents apiece net. This pocket level tells in an instant which way the work is out. It is nicely nickeled and polished. Other specialties are beam calipers in any graduation, vernier or metric system; micrometers, spherometers, germ-proof filters and fine tools for all trade and scientific purposes.

THE WILMARTH & MORMAN Co., Grand Rapids, Mich, report a large number of shipments of grinders, among which are: Three to Bombay, one to Rangoon, one to Singapore, two to Hong Kong, two to Calcutta, three to Shanghai, one to Manila, one to Montreal, and one to the University of Wisconsin, Madison. In addition to four "style N" wet drill grinders, with self-contained motor, shipped recently to the United States Government, they have orders for one for the Allis-Chalmers Co., one for the Washington Navy Yard, and one for the Niles-Bement Pond Tool Co.

THE COLBURN MACHINE TOOL Co. have chosen a fine factory site at Franklin, Pa., fronting on the Lake Shore tracks, a distance of 540 feet, where they intend to erect a new plant. Their main machine shop will be 100 by 200 feet, one story high, the front portion, however, rising to a height of three stories, and which will contain the offices and drafting room. They will also have an engine room, 30x45 feet; a boiler room, 27x45 feet; a blacksmith shop, 30x50 feet; a toilet room and lavatory, 25x50 feet, all buildings to be of brick and steel construction.

SEVERAL important changes have recently been made in the management of the Mossberg & Granville Mfg. Co., Providence. At the recent election Messrs. W. W. Orr, V. I. Cumnock, E. C. Moen, A. R. Whitney, Jr., and Joseph W. Harriman, all of New York, and Elisha H. Howard, of Providence, were made directors. The Board of Directors organized by electing Howard C. Smith, of New York, President; Elisha H. Howard, Vice-President, and E. C. Moen, Secretary and Treasurer. V. I. Cumnock was made Chairman of the Executive Committee. George A. Clark, formerly of Lowell, Mass., has been appointed General Manager to replace Mr. W. W. Gibbs, who resigned.

THE HYATT ROLLER BEARING Co., Harrison, N. J., inform us that they received a contract for some 500 roller bearing hangers for the new mill of the Atlas Tack Co., Fairhaven, Mass., which contract was awarded through Lockwood, Greene & Co., Boston. They are also making a number of heavy jack shaft bearings for the Washburn-Crosby Co., Minneapolis, and are installing a new jack shaft drive, containing a new electric drive that includes a number of heavy bearings of the Hyatt type, for the American Cigar Co., Jersey City. The mill of the Champion Coated Paper Co., Hamilton, O., will be equipped throughout with Hyatt roller bearings.

SCHISCHKAR & Co., of Birmingham, England, have purchased from the Acme Machine Screw Co., of Hartford, Conn., their patents on their automatic screw machines which were granted for the United Kingdom of Great Britain and Ireland. These patents Messrs. Schischkar & Co. have disposed of to P. F. Pease & Co., of Darlington, London and Worcester, England, whose intention it is to manufacture all sizes of these machines for the English market. Messrs. Schischkar & Co., who are the sole European agents for the Acme Machine Screw Co., have sold fifty of these machines in Great Britain in ten months.

THE NEW PROCESS RAW HIDE Co., Syracuse, N. Y., through their English agents, Messrs. Geo. Angus & Co., have received during the month of October trial orders for their "New Process" noiseless pinions from eleven of the leading electric railway companies in Great Britain. These trial orders will doubtless lead to a considerable trade in the near future. The company report their trade in the general machinery line as steadily increasing, especially in the case of motor-driven machine tools where noiselessness is very essential. Since the announcement a couple of months ago that they are in position to furnish accurately-cut metal gears also, the number of orders received for work in this line has been very gratifying, and points favorably to an extended trade.

THE AMERICAN FOUNDRY & MACHINE Co. have taken a plant at Glenville, Pa., a machine shop and foundry, which is now in running shape and employing fifty hands. The plant will be run as an adjunct to their new plant in Hanover, Pa., which they will have ready for occupancy April 1st, and they expect to employ a considerable number of machinists, as well as foundrymen. Their foundry will be a